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MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

MAPS

The maps attached to this report show (1) the main geographic and physiographic features, (2) the location and extent of the different soils, (3) the location and percentage of each section under cultivation, and (4) the U. S. Geological Land Classification.

Geographic and Physiographic Features.—The maps show the location of the more important drainage courses, towns, and railways; and the extent of mountains, lakes, and badlands is indicated. The general relief of the land is divided into the following phases; namely, (1) undulating to rolling, (2) sharply rolling land or land too rough for cultivation, (3) plateaus and benches, (4) mountains, (5) badlands, and (6) badland basins.

Soil.—The location, extent and relationship of the soils in the county are shown on the soil map. The chief purpose of this map is to provide soil information for the classification, interpretation, and extension of data regarding agricultural production, and also to provide a factual basis for the development of sound agricultural programs for rural land use.

Area Under Cultivation.—A record of the approximate acreage under cultivation was made at the time of this survey for the purpose of locating the more intensely cropped sections and for studying the conditions under which these sections are more favorably adapted to agriculture than others. The approximate percentage of each section in crop, in fallow, and in tame pasture is shown on the map.

Land Classification.—The classification of the public lands in the western states, undertaken by the United States Geological Survey in 1915, was based largely upon the topography and vegetation and in no instance was any information obtained in regard to the soil relationships in any one county or between two or more. This classification is of value in indicating the general adaptation of the land to agriculture. The utilization of the land is indicated on the map as follows: (1) farm lands, (2) farming grazing land, (3) grazing forage land, (4) grazing land, and (5) non-tillable grazing land. Other features, such as the location of the irrigated districts, also are shown.

Soils Of Fergus County

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LOCATION

Fergus County is located approximately in the geographical center of the State of Montana. It is one of the largest counties in the state, covering 4327 square miles between Townships 10 and 24 North of the Base Line Montana and Ranges 11 and 27 East of the Principal Meridian Montana. Its extreme measurements are 114 miles (east and west) and 78 miles (north and south). The Missouri River and Arrow Creek form natural boundaries on the north and northwest. Several isolated mountain ranges such as the Moccasins, the Judith, and the Big and Little Snowys rise within its borders and bound a high tableland area, known as the Judith Basin. The county created by the Territorial Legislature in 1886, covered a large area in central Montana, but due to the development of dry land farming it has been subdivided to form several counties.

GEOGRAPHIC AND PHYSIOGRAPHY FEATURES

The more prominent topographic or physiographic features of central Montana are isolated mountain ranges separated by low divides and often enclosing high tableland areas. These isolated mountain ranges rise several thousand feet above the tablelands and rolling plains and are capped with ancient crystalline, sedimentary rocks in which igneous intrusions often occur. Fergus County covers an area having the features of the plains, foothills, and mountains. Its more important physical features as shown on the topographic map are (1) the Big Snowy, Little Snowy, Judith, and Moccasin mountains, (2) the foothills and detached buttes, (3) the Judith Basin and other gravel-capped benchlands, (4) the rolling plains in the northeastern part, and (5) the badlands or breaks along such streams as the Missouri and Judith rivers and Arrow Creek. The tablelands, extending out from the mountains and foothills, are traversed by numerous mountain streams flowing through deep and relatively narrow valleys. The rolling plains are featureless except for low sandstone and shaly ridges.

TOPOGRAPHY

Glaciation

The Keewatin ice sheet covered the northeastern part of the county during the Illinoian or Iowan glaciation.* It extended into the valleys of such streams as Two Calf, Armells, and Little Crooked creeks and deposited a shallow covering of drift and probably some glacial lake sediment over an area lying east of Woodhawk Creek, within 10 or 15 miles of the Missouri River. The glaciated area lies below 3200 feet in elevation and is characterized chiefly by erratic boulders, by a shallow covering of glacial gravel and by numerous shallow, scabby depressions or basins on the more level uplands. The physical features of the area were not modified greatly by the ice sheet.

Mountains

The Big Snowy, Little Snowy, Judith and Moccasin mountains cover approximately 298.5 square miles in Fergus County. The higher parts of the Big Snowy and Judith mountains consist of bald peaks and ridges with talus covered slopes. Lodge pole pine is the chief timber cover in the higher mountainous sections and yellow pine at the lower. Quaking aspen and willows occur on the poorly drained slopes and in gulches. Sedges predominate over the grasses in the open mountain parks and shrubs make up most of the underbrush. The type of vegetation found in the mountains is somewhat better adapted to the grazing of sheep than cattle. The grazing season in the higher mountains extends from the middle of June to early September.

Big Snowy Mountains.—The Big Snowy Mountain uplift influences the topography and geology of a large area in central Montana. It is separated from the Big Snowy and Little Rocky Mountain uplifts by a faulted area in the northern and northeastern parts of the county. On its faulted and dissected slopes, rocks ranging in age from Cretaceous to Carboniferous are exposed. The higher part of the uplift, covering an area 24 miles long and 6 to 10 miles wide, rises in the southern part of the county and extends across the county line into Golden Valley and Musselshell counties. The Western part of the area, capped with the Madison limestones and lying 3000 feet or more above the Judith Basin, is known as the "Big Snowy Mountains", while the eastern part lying at a lower elevation is known as the "Little Snowy Mountains". The backbone of the Big Snowy Mountains is a sinuous limestone ridge having an elevation of approximately 8000 feet. The higher peaks, such as Windy Point and Big Snowy,

*William C. Alden—Physiographic and Glacial Geology of Eastern Montana and adjacent areas. U. S. G. S. Professional Paper 174, 1932.

have altitudes of 8000 and 8533 feet respectively. The limestone exposures below the crest of the mountains are eroded into sharp ridges dissected with deep limestone canyons. The mountains are very rugged and steep with few trails crossing the area. Half Moon Pass, having an elevation of 7300 feet, is a scenic gap in the eastern part of the mountains.

Little Snowy Mountains.—The area known as the "Little Snowy Mountains" is in reality a part of the foothills of the Big Snowy Mountains. A high ridge with steep dissected southern slopes extends east from the Big Snowy Mountains for 10 to 12 miles and terminates in a high butte known as "Durfee Dome". North of this ridge lies a high tableland area, sloping gently to the east and traversed by deep stream valleys. The tracts between the stream valleys known as Alaska, Middle and South benches lie above 6000 feet in elevation and are capped with resistant limestone and sandstones of such geologic formations as the Quadrant.

Judith Mountains.—The Judith Mountains, lying 18 miles northeast of the Big Snowy Mountains, cover an irregular area 18 miles long and 3 to 12 miles wide in the central part of the county. These mountains lie chiefly between 5000 and 6000 feet in elevation with several of the higher peaks rising to 6000 and 6200 feet. The mountains were formed by an igneous intrusion which raised sedimentary rocks of Jurassic and Carboniferous age several thousands feet above rocks of Cretaceous age on the slopes of the Big Snowy Mountain uplift. The outcrops in the mountains are largely of limestone with local intrusions of igneous rock. The Judith Mountains, consisting of broken ridges often separated by gaps, have a rugged relief with their slopes seamed with limestone canyons. Maiden Canyon is a limestone gap or pass in the mountains between Maiden and Gilt Edge. Black Butte, lying a few miles east of the mountains and towering several thousand feet above the rolling plains, is the most conspicuous land mark in the eastern part of the county.

Moccasin Mountains.—The Moccasin Mountains, 8 miles northwest of the Judith Mountains, cover an area 15 miles long and 3 to 5 miles wide. The valley of Warm Spring Creek cuts through the area and divides the mountains into two short ranges known as the north and south Moccasin mountains. The higher ridges and peaks have elevations of approximately 5500 feet and rise several thousand feet above the gravel-capped tablelands to the west. These mountains also are capped with limestone in which igneous intrusions occur. The ridges are quite rugged and their slopes are dissected with canyons.

Foothills.—The Big Snowy Mountains have a steep gradient on the south, but to the west and north the slope is less, and the

more resistant limestone and sandstone formations often form encircling ridges and steeply sloping benches about the mountains. The southern slopes of the mountains rise directly above limestone gravel-capped tablelands, dissected with stream valleys. Sandstone ridges, often capped with stony outwash, extend west and southwest from the mountains for 6 miles or more. The foothill area north of the mountains, also dissected with numerous stream valleys, is 3 to 10 miles wide and to the east grades into the McDonald Creek Divide, lying between the Big Snowy and Judith Mountains. The foothills lie between 4500 and 6000 feet in elevation.

A high broken area grading into a broad sandstone ridge lies north of the Little Snowy Mountains. This ridge, dissected with intrenched stream valleys in the eastern part, extends east to the county line and forms a portion of the divide between the South Fork of McDonald and Flatwillow creeks. The face of the ridge between the mouth of Porter Creek and Tyler is a bold sandstone escarpment rising several hundred feet above the stream valley. The area above the escarpment slopes steeply to the north and is broken with intrenched stream valleys between which lie stony steeply sloping tracts or benches. The divide, sloping gently to the east, has an elevation of 4000 to 6000 feet. East of Tyler, gravel-capped benches extend east along Flatwillow Creek below the Little Snowy Mountains.

The Judith Mountains are bordered on the north and west by high sandstone ridges locally covered with a stony outwash. These foothills, also dissected with numerous mountain stream courses, lie within 3 to 6 miles of the mountains and are between 3600 and 4200 feet in elevation. South and east of the mountains, the narrow foothill area encircles a large basin, characterized by low gravel-capped benches and ridges between open stream valleys, which extend east to the county line. A sandstone ridge grading into a shaly ridge extends east from Black Butte.

The Moccasin Mountains also are bordered by a foothill zone varying from one to 6 miles wide. This foothill area lies below 4500 feet in elevation and consists largely of sandstone and shaly ridges often covered with stone outwash between the coulees.

Mountain Divides.—The area between the different mountain ranges provides natural traffic courses, often with steep but uniform slopes. The divide known as the "Judith Gap" between the Big Snowy and Little Belt mountains is about 12 miles long and ranges in elevation from 4800 to 5500 feet. The McDonald Creek Divide between the foothills of the Big Snowy and Judith mountains is approximately 8 miles long and varies from 4100 to 5500 feet in elevation. East of Lewistown, this divide is eroded into irregular shaped tracts capped with sandstone. The divide be-

tween the Judith and Moccasin mountains is about 6 miles long and its elevation is between 4000 and 5000 feet. The terraced gap between the north and south Moccasin mountains lies at a lower elevation.

Tablelands and Benches

Judith Basin.—The Judith Basin covers an area in central Montana approximately 45 miles long and 30 miles wide between such mountain ranges as the Highwood, Little Belt, Big Snowy, Judith and Moccasins. The basin is characterized by gravel-capped tablelands or benches separated by deep intervening stream valleys. These benches, extending beyond the limits of the basin almost to the breaks of the Missouri River, have smooth surfaces, gentle slopes, and range in elevation from 4900 feet below the mountains and foothills to 3400 feet above the breaks of such streams as the Judith River and Arrow Creek. The benches occupy different erosional levels and are capped with rock and gravel carried out of the different mountain ranges. The gravel deposit, probably laid down during Miocene and Pliocene times, has a maximum thickness of 80 feet on some of the benches, and in Fergus County it consists largely of limestone gravel. The stream valleys are intrenched 50 to 100 feet in the tablelands near the mountains and foothills and 300 feet or more above the breaks of the Missouri River and Arrow Creek.

The gravel-capped benches in the Basin are known locally by their location with reference to towns and streams. The irregular, gravel-capped area west of Lewistown between the Moccasin and Big Snowy mountains and between the Judith River and McDonald Creek Divide has an extreme length of 17 miles (north and south) and a maximum width of about 15 miles. The eastern part of this area is referred to usually as the Casino Bench, the central part as the Cottonwood Bench, and the western part as the Moore or Beaver Creek Bench. The bench, east of Cottonwood Creek, having some limestone rock on the surface within one or 2 miles of the foothills, has a gentle slope to the north and is dissected locally with deep coulees above Big Warm Spring Creek. The area west of Beaver and Cottonwood creeks has a gentle slope to the northwest and grades into sandy, gravelly secondary benches without distinct contours along the Judith River and Ross Fork Creek. The western part of the area is dissected with shallow gravelly drainage courses and local basins or slopes, which modify the general features. The area has good surface drainage, except for a few seeped tracts at the head of drainage courses. East of Ross Fork Creek rises a higher bench which grades into a gravelly broken stony ridge to the south along Beaver Creek. It is capped with limestone and other rock and gravel. The small bench between Beaver and Cottonwood

creeks carries a fair amount of rock on a portion of its surface. Secondary or lower benches, which often are quite gravelly, also occur along Beaver, Cottonwood and Big Warm Spring creeks.

There are a number of dissected, gravel-capped benches extending across the county line in the west central part of the county. The northern part of the Benchland Bench, also known as the "Indian Creek Bench" lies between Sage Creek and the Judith River. The Coyote Bench, which grades into a lower and less gravelly bench north of Hoosac, rises between Dry Wolf and Coyote creeks. The Stanford Bench between Wolf and Coyote creeks occupies a lower erosional level or secondary bench, and a portion of Arrow Creek Bench extends east of the town of Coffee Creek. These benches in Fergus County are eroded into flat-topped, gently sloping, gravelly tongues, and their gravelly borders often are indented with deep coulees. The eastern slopes of some of the benches, such as the Benchland Bench, are gentle and grade locally into secondary benches without distinct contours.

Secondary or lower benches often lie below the higher benches along some of the larger streams such as the Judith River and Wolf and Warm Springs creeks. The Danvers Bench is characterized by a silty clay deposit over limestone gravel and covers a tract along the Judith River 8 miles long and one to 3 miles wide. A similar tract 5 miles long and 2 miles wide lies across the river from this bench. The gravelly Deerfield Bench, approximately one mile wide and 6 miles long, borders Warm Springs Creek; narrow, gravelly, secondary benches lie along Wolf Creek, east of Denton. Other gently sloping tracts having the relief of benches occur along Sage and other creeks.

Coffee Creek Bench.—The limestone gravel-capped tablelands extend beyond the limits of the area known as the Judith Basin and form the divides between the deeply intrenched stream valleys in the northwestern part of the county. The gravel deposits become rather shallow on the northern extremities of these tablelands and probably do not average more than 10 to 15 feet in depth. The Coffee Creek Bench, the southern part of which is known locally as the "Arrow Creek Bench" lies between Arrow and Coffee creeks and covers an area in Fergus County approximately 15 miles long and one to 8 miles wide. The bench, capped with silty clay material overlying limestone gravel, slopes to the east and north, and its borders are indented with deep coulees. Wind-blown material from the shaly breaks of Arrow Creek rise as low hummocks along its western border.

Alton and Everson Benches.—The higher levels of the divide between Wolf and Coffee creeks, north of Denton, are capped with limestone gravel within 7 to 8 miles of the Missouri River.

South of Blood Creek lies an area about 6 miles long and 6 miles wide sloping gently to the east from a sandstone escarpment rising several hundred feet within 2 to 3 miles of Coffee Creek. Irregular gravel-capped benches between which lies a rolling basin covered with silty clay material containing some gravel occur above the sandstone escarpment and above the valley of Wolf Creek, north of Denton. This basin, breaking to the east with different gradients or slopes, grades into a rolling residual sandstone-capped area having a shallow covering of gravel on the surface above the secondary benches along Wolf Creek. The basin and surrounding benches, usually referred to as the Alton or Denton area, is dissected with deep coulees in the eastern part. North of Blood Creek for 6 miles or more, the isolated, irregular shaped, gravel-capped tracts rise above a broken shaly residual area dissected with deep coulees.

The Everson Bench (7 miles long and one to 5 miles wide) covers the northern part of the divide south of a gap connecting Arrow Creek and the Judith River. This gravel-capped bench has a gentle slope to the east and lies above sandstone and shaly escarpments forming the breaks of Arrow Creek and the Judith River. The eastern part of the bench is eroded into long, gravelly tongues between the deeply intrenched coulees. Low silty clay and sandy hummocks occur occasionally along its western border.

Bear Springs Bench.—Deposits of limestone gravel occur on the higher parts of the divide between Wolf Creek and the Judith River. Northeast of Hoosac for 8 to 10 miles, the broken sandstone-capped divide, rising several hundred feet above the levels of the stream, has a few gravel-capped tracts above the mouth of Sage Creek. North of Bear Springs for 11 to 12 miles, and lying 300 to 400 feet above the intrenched streams, the crest of the divide is the gravel-capped, gently sloping, flat-topped ridge, varying from one-fourth to one and one-half miles wide. Its borders are indented with short, deep coulees above the breaks of the stream. A secondary bench known as the Bear Springs Bench covers an area 4 miles long and 3 miles wide, northeast of the Bear Spring Post Office along the Judith River. It is capped with silty clay material overlying gravel and its eastern border is indented with coulees.

Other Gravel-Capped Benches.—The benches bordering the Big and Little Snowy mountains on the south are capped with limestone rock and gravel. These benches have a steep slope to the south and are separated by intrenched stream valleys. East of Tyler, a gravel-capped bench dissected with deep coulees rises above Flatwillow Creek and extends east along the stream into Petroleum County. This bench, sloping gently to the east and north, is very stony below the Little Snowy Mountains. Another

limestone gravel-capped bench (6 miles long and one to one and one-fourth miles wide) lies south of Grass Range and forms the divide at the head of Elk Creek. Tracts of limestone gravel occur on the divides east and west of Grass Range and also along McDonald Creek.

Stony outwash from the Judith Mountains covers the benches along Ford and other creeks in the east central part of the county. These benches, having a gentle slope to the east and lying at different erosional levels, are from one to 3 miles wide and extend from the Mountains into Petroleum County. The stony gravel deposit becomes rather shallow to the east and often overlies dark colored shales at comparatively shallow depths. The benches within 6 to 8 miles of the mountains often are very stony and have fairly steep gradients. Outwash from these mountains also covers the bench north of Roy and isolated gravel-capped tracts along Box Elder, Bear and Little Bear creeks. The stony bench north of Roy (12 miles long and one to 2 miles wide) is very gravelly and underlaid with shale at a comparatively shallow depth in the eastern part. A gravel-capped area, eroded into irregular tongues by the branches of Armells Creek, covers the divide north of the Judith Mountains between Dog and Armells creeks. The gravelly borders of these benches are indented with deep coulees and lie several hundred feet above the bottoms of the deep coulees. A gravelly, scabby secondary bench (8 miles long and 3 miles wide) lies along Armells Creek below the higher gravel-capped areas.

The divide north of the Moccasin Mountains for 6 to 8 miles is capped with rock and gravel which becomes quite shallow south of Winifred along Dog Creek. West of Dog Creek between Winifred and Suffolk, the gravel-capped area has a gentle slope to the north and is not broken badly with coulees. Irregular shaped gravel-capped tracts occur on the divide between Plum and Box Elder creeks northwest of these mountains, and a few gravelly secondary benches lie along some of the streams heading in the mountains.

A high bench rises above the breaks of the Missouri River between Arrow Creek and the Judith River in the northwestern part of the county. This bench is capped with a shallow covering of red quartzite gravel, which is not related to any of the rocks found in the different mountain ranges. In the northeastern part of the county, scabby glaciated gravelly ridges or benches having a shallow covering of red quartzite and glacial gravel on the surface stand out conspicuously above the surrounding shaly hills and ridges. Travertine deposits locally cover small gently sloping tract in the foothills of the Big Snowy Mountains. Other stony

gravelly deposits occur on isolated buttes and ridges and secondary benches along the streams in different parts of the county.

Ridges and Buttes

The breaks of the Missouri River in the northern part of the county lie below a narrow, broken, sandstone-capped ridge which extends east from the Judith River almost to the mouth of Two Calf Creek. The slopes of this ridge broken with deep coulees have a rugged relief. Isolated buttes detached from the ridge rise above the breaks of the stream. A number of low sandstone ridges separated by small basins or depressions occur in the faulted area in the north central part of the county. Another broken sandstone-capped area lies along Armells Creek north of the town of Armells.

North of Valentine along Blood Creek, an area 8 miles long and 2 to 3 miles wide is eroded into high sandstone ridges and buttes. West of this stream is another similar area 12 miles long and one to 3 miles wide. A sandstone ridge with a bold escarpment on the north extends east from Black Butte for 6 to 8 miles. Southeast of Grass Range along Elk Creek a sandstone-capped ridge is eroded into broken ridges and buttes of which Button Butte, north of Battrick is the most conspicuous. The valleys of such streams as the North Fork of McDonald, Ford, Little Bear, and other creeks in the east central part of the county often are bordered by steep shaly escarpments rising 75 to 100 feet or more. Similar escarpments are found along Pike, Willow, Armells, and other creeks in the southeastern and northeastern parts. Barren shaly ridges often are found on the eroded slopes in the eastern half of the county.

Badlands And Badland Basins

The breaks of the Missouri and Judith rivers and other streams in the northern part of the county were undifferentiated and are designated on the soil map as badlands. These breaks, lightly covered with stunted yellow pine, consist chiefly of clay ridges and buttes separated by deep coulees with barren shaly slopes. Sandstones cap locally the higher buttes and ridges. Isolated tracts of shaly buttes and eroded shaly areas occur in the northern and east central parts of the county. These tracts are quite barren except for patches of creeping juniper. Badlands classified as non-tillable grazing land on the land classification map cover 291.5 square miles, all of which is utilized for the grazing of livestock. The most important economic range forage on the clay ridges is a species of wheat bunch grass (*Agropyron spicatum*) which is considered an excellent range

forage during the winter months. Badlands have a very low live-stock carrying capacity.

Barren shaly ridges and deeply intrenched stream courses form the badlands along the Missouri River and Armells and Two Calf creeks in the northeastern part of the county. West of this area, along the Missouri and Judith rivers and Arrow, Dog, and other creeks, the gullied clay ridges and shaly escarpments are capped with sandstone at the higher elevations. These badlands or stream breaks rise 300 to 500 feet above the level of the streams, and cover an area 2 to 5 miles wide along the stream valleys. A light stand of timber occurs on the tops of the ridges. North of Valentine shaly badlands cover an area 4 miles long and 2 to 3 miles wide. Shale exposures along Little Crooked and other creeks in the northern and eastern parts of the county are eroded into gullied clay hills and ridges.

Many of the stream valleys in eastern and northeastern parts of the county are broad alkali flats, approaching the character of badland basins. The shaly ridges in the north central and northeastern parts of the county often are separated by barren scabby basins also approaching the character of badland basins.

Rock Outcrops

Limestone outcrops on the southern slopes of the North Moccasin Mountains, and sandstone and shale are exposed locally on the southern slopes of the Judith Mountains and on the divide east of Lewistown. Shale exposures lightly covered with grass also cover a small area on the divide between the Moccasin and Judith mountains. These rock exposures, designated as rock outcrops on the soil map, are devoid of vegetation except for a few scrubby pine. Rock outcrops, classified as non-tillable grazing land on the land classification map, cover 8.7 square miles. The tracts have a very low livestock carrying capacity.

Swamps

A poorly drained tract covered with quaking aspen and willows occurs in the foothills of the Big Snowy Mountains. This tract covers 1.5 square miles and is designated as a swamp on the soil map.

Forests

Stunted yellow pine, cedar, and creeping juniper occur in the stream breaks, on divides and on shale and sandstone outcrops in the northern and eastern parts of the county. The tracts have an open stand of timber and occur largely in eroding areas. Where the soils were not greatly modified by the timber cover, they were grouped with the nearest related soil and designated as a timbered phase of this soil on the soil map.

Open to fair stands of timber cover the McDonald Divide and other divides in the central and southeastern parts of the area. Yellow pine predominates on the tracts. The soils are chiefly coarse sandy loams underlaid at comparatively shallow depths with non-crystalline and crystalline sandstones of such geologic formations as the Kootenai and Ellis. These coarse sandy loams, designated on the soil map as a timbered phase of the Teton Stony Loams, have a shallow covering of pine needles, below which the structureless sands often have a bleached yellowish color.

Fair to dense stands of timber cover the higher foothills of the Big and Little Snowy mountains. Lodge pole pine with numerous shrubs forming the underbrush is the chief cover. The soils of this area have developed over shales, sandstones, and limestone of such formations as the Quadrant and Ellis. The soils developed over limestone have several inches of leaf mold on the surface. The surface soils are yellowish-brown compact silty clay loams, and the subsoils often are mottled and streaked with brown and black organic matter. Disintegrated limestone underlies the area at 2 to 3 feet or more and often outcrops in the more broken sections.

The area designated as forests is classified as non-tillable grazing land on the land classification map and covers 176.5 square miles. The type of vegetation found in the forests is more palatable to sheep than to cattle during the 6 months the area is open for grazing.

A part of the county (where it takes in the Big Snowy Mountains) is in the Jefferson National Forest. The grazing season in the National Forest opens in June and closes in September. Grazing permits are obtained from the Forest Supervisor located in Great Falls, Montana.

DRAINAGE SYSTEMS AND AREAS

The drainage of Fergus County is influenced by the different mountain ranges and by the divides connecting these mountain ranges. The Missouri River, which forms the northern boundary of the county, receives directly or indirectly the drainage from the area. The mountains and high divides separate the county into three principal drainage basins, namely, the Musselshell, the Missouri and the Judith rivers. Arrow Creek drains a small area in the extreme northwestern part of the county. The larger streams, heading in the mountains, are at flood stage during the spring runoff, which usually occurs in March and early April and again in May and June when the streams are swollen by the seasonal rain and by the melting snow in the mountains. Many of the streams have a perennial flow in the mountains and foot-

hills but during the late summer and fall their flow in the plains often disappears in the stream gravels or sinks into a chain of water holes, which are likely to become stagnant unless flushed out by showers.

Musselshell River Drainage Basin

The streams heading on the eastern slopes of the Snowy and Judith mountains flow east and enter the Musselshell River in Petroleum County. Those rising on the southern slopes of the Snowy Mountains flow south and southeast and join this river in Golden Valley and Musselshell counties. Several streams rise on the shaly divide in the northeast part of the county and flow east into the Musselshell River. The larger perennial streams rising in the mountains and on the higher divides and uniting with the Musselshell River are, namely, Careless, Cameron, Pocket, South Willow, Willow, Flatwillow, Pike, Yellow Water, Elk, McDonald, Ford, Bear, Little Bear, Box Elder, Blood, and Little Crooked. The intermittent branches of many of these streams have perennial springs along their courses in the sandstone and gravel-capped areas.

Careless, Cameron, Pocket, South Willow and Willow creeks.—These and many of their branches are small perennial streams heading on the southern slopes of the Big and Little Snowy mountains. These streams emerge from the mountains through limestone canyons and enter entrenched valleys in the gravel-capped tablelands below the mountains and foothills. Willow Creek, heading in the Little Snowy Mountains southwest of Pine Grove, is a fair-sized perennial stream flowing through a deep valley below the timbered covered slopes of the mountains and tablelands in Fergus County.

Flatwillow Creek.—This is one of the largest perennial streams in the eastern part of the county. The North Fork of this stream rises in Half Moon Pass and flows east through an entrenched valley below the high tablelands. The South Fork of this stream, also rising in the Big Snowy Mountains and flowing northeast through a similar valley, unites with the North Fork a few miles west of Tyler. McCarthy and Hell creeks flow through sandstone canyons to unite with the North Fork, in the high tableland area. Potter Creek, rising on the high divide to the north, flows southeast through a deep wooded valley and unites with the North Fork below the tablelands. The valleys of the North and South Forks of Flatwillow Creek average about one-quarter of a mile wide below the wooded tablelands. East of Tyler the course of the stream is to the southeast through a poorly drained valley ranging from one-half to one mile wide. The valley is bordered on the south by a shaly escarpment rising

75 to 100 feet and on the north by the stony slopes of sandstone-capped benches.

Pike, Yellow Water and Elk creeks.—Pike Creek is a small perennial stream heading in a sandstone-capped area north of Tyler. It flows east through a sandstone canyon and enters Flatwillow Creek across the county line. Yellow Water and its branches head on the broken slopes of Button Butte, northeast of Battrick, and flow east also through sandstone canyons. West of the county line this intermittent stream with a few water holes along its course passes through a heavy basin bordered on the east by a shaly escarpment. Elk Creek is a small perennial stream heading on the divide west of Battrick and flowing northeast through an enclosed valley less than one-eighth mile wide. East of the gravel-capped bench south of Grass Range its course is to the southeast and its valley along the county line is nearly one-half mile wide. Yellow Water and Elk creeks unite before entering Flatwillow Creek in Petroleum county.

McDonald Creek.—The South Fork of McDonald Creek rises on the high divide north of the Snowy Mountains and flows east as far as Becket where its course changes to the northeast. The North Fork of this stream heads on the McDonald Creek Divide east of Lewistown and flows east uniting with the South Fork north of Grass Range. The valley of the South Fork averages about one-quarter mile wide, and east of Piper it is bordered on the north by a sandstone escarpment and on the south by the broken slopes of sandstone-capped benches. The valley of the North Fork east of Novary averages somewhat wider and is bordered on the north by a shaly escarpment and on the south by sandstone and gravel-capped benches. East of the junction of the North and South Forks, the valley of McDonald Creek is about one-half a mile wide and locally its heavy bottom land is in need of drainage. Alkali Creek below the foothills of the Judith Mountains is an intermittent stream flowing through a small valley and entering the North Fork at Novary. Chippewa Creek, also rising in the foothills of the Judith Mountains north of Gilt Edge, has a continuous flow most of the year. It flows southeast through a small poorly drained valley below gravel-capped benches and rolling sandstone-capped uplands and unites with McDonald Creek northeast of Grass Range. The flood waters and perennial flow of McDonald Creek are diverted onto irrigated lands along its course.

Fords Creek and its North Fork, uniting across the county line, rise in the Judith Mountains and flow east below stony benches and shaly escarpments. These streams carry a fair volume of water during the spring runoff and early summer months, but later on in the season they become small perennial

streams. Fords Creek flows through a stony, poorly drained valley averaging one mile wide for 5 to 6 miles below the foothills. Its valley becomes more narrow to the east and grades into an alkali flat within 6 miles of the county line. Its northern branch also flows through a small poorly drained valley below the foothills and stony benches and becomes an alkali flat within 7 miles of the county line.

Bear and Little Bear creeks.—Bear Creek and its branches rise on the northern and northeastern slopes of the Judith Mountains and flow in a general easterly direction. These small perennial streams flow through intrenched valleys in the foothills. Below the foothills, Bear Creek enters an alkali flat averaging more than one-half mile wide. Little Bear, rising on the southern slopes of Black Butte is an intermittent stream uniting with Bear Creek across the county line. Its valley is largely an alkali flat below the stony benches.

Box Elder Creek.—On the northern slopes of the Judith Mountains southwest of Fergus, Box Elder Creek heads, then flows north and east uniting with Bear Creek across the county line. It is a fair-sized perennial stream flowing through an open valley averaging one-fourth mile wide through the foothills. East of Fergus for about 9 miles, its poorly drained valley is one-half mile wide. The stream enters a broad alkali flat approximately 8 miles this side of the county line.

Blood and Crooked creeks.—Blood Creek and its branches are intermittent streams heading in an area of rolling clay hills and ridges 10 to 12 miles northwest of Valentine. Most of its branches join the stream in an alkali basin which gives way to a small intrenched stream valley below the gentle slopes of the sandstone ridges north and west of Valentine. Crooked Creek is an intermittent stream rising northeast of Roy and draining a large area of rolling clay hills and ridges in the northeastern part of the county. This stream and its branches are intrenched in alkali flats along most of their courses. The runoff of the area is large and at times the stream carries a large volume of water.

Missouri River Drainage Basin

The Missouri River drainage basin lies north of the Judith Mountains and east of the divide which extends north from the Moccasin Mountains along the Judith River. The larger streams uniting with the Missouri River east of the mouth of the Judith River are Sand, Armells, Two Calf, Woodhawk, and Dog creeks.

The Missouri River forms the northern boundary of the county and is the largest stream in the central part of the state. It has an average width of 75 to 100 yards and during low water flows 10 feet or more below its high water level. Its normal dis-

charge in this part of the state is 7171 second feet with a maximum discharge of 25,410 second feet. The stream meanders in a deeply intrenched valley ranging from one-half to three-quarters of a mile wide and bordered by high shaly escarpments eroded into barren gullied clay ridges. West of Woodhawk Creek the higher ridges are capped locally with sandstone. The valley floor is cut into irregular shaped tracts by the meanders of the stream and by the cut bank coulees leading down from the breaks. Locally along its course, the stream has gravelly bottoms, which are of importance to stockmen as watering places. The heavy wash below the breaks often is quite barren.

Sand Creek is an intermittent stream heading in an area of rolling clay hills in the northeastern part of the county and entering the Missouri River about 8 miles west of the county line. It flows through an intrenched valley, averaging about one-eighth mile wide through the breaks of the Missouri River.

Armells Creek is a perennial stream rising on the northern slopes of the Judith Mountains and entering the Missouri River about 8 miles west of the mouth of Sand Creek. It carries a fair volume of water during the spring runoff, but late in the season it is likely to shrink into a number of stagnant water holes along its lower course. It flows through a small intrenched valley along most of its course. Its larger branches, such as Fargo, Gerhard, and other creeks, are intermittent streams of a cutbank type heading in areas of rolling clay hills and ridges. Some of its eastern branches head in poorly drained, alkali impregnated basins.

Two Calf and Woodhawk creeks.—Two Calf Creek is an intermittent stream heading on a sandstone ridge above the breaks of the Missouri River in the north central part of the county. It flows southeast in a deeply intrenched valley and enters the Missouri River about 5 miles west of the mouth of Armells Creek. Woodhawk Creek is another intermittent stream with a few perennial springs along its course. It flows east in a small valley intrenched in a heavy basin and badlands above its entrance into the Missouri River.

Dog Creek is a perennial stream carrying a fair volume of water during the spring runoff. Its perennial branches head in the Moccasin and Judith mountains and unite in a wide bottom south of Moulton. Its valley averages one-fourth mile wide as far north as Winifred where it becomes enclosed in the shaly breaks.

Judith River and Arrow Creek Drainage Basins

The area included in the Judith River and Arrow Creek drainage basins covers the west central and northwestern parts of the county. The Judith River and its eastern branches, such as Ross Fork, Big Warm Spring, Warm Spring, Ming, Box Elder

and Salt creeks, and its western branches such as Sage and Wolf creeks drain the greater part of the area. Arrow Creek and its branch, Coffee Creek, drain the extreme northwestern part. These streams and many of their branches have a continuous flow during the spring and early summer, but later on in the season the flow of some of them disappears in the stream gravels.

Judith River rises in the Little Belt Mountains and has a fair flow during the spring and early summer. It has a normal discharge above its mouth of 648 second feet and a maximum discharge of 1128 second feet. The stream enters the county in the southwestern part, flows almost due north, and discharges into the Missouri River. Its valley, enclosed in shaly bluffs and breaks along most of its course in the county, averages about one-fourth mile wide. The valley floor is carved into irregular shaped tracts by the meanders of the stream.

Ross Fork Creek is a small perennial stream heading in the Judith Gap in Judith Basin County and entering the Judith River a few miles southeast of the town of Ross Fork. It flows through a narrow valley intrenched in secondary benches below the high gravel-capped tablelands. Its perennial branches, such as Meadow, Dry, and East Buffalo, flow through fairly open valleys, ranging from one-eighth to one-half mile wide, and unite in a broad poorly drained basin below the foothills. Trout Creek, heading in the foothills of the Big Snowy Mountains, has a small perennial flow and its open valley is less than one-third mile wide. Rock Creek rises in the Big Snowy Mountains and flows through a fairly wide valley for 4 miles below the foothills, where it becomes more enclosed. Above Ross Fork Creek it is deeply intrenched.

Big Warm Spring Creek.—The perennial branches and forks of Big Warm Spring Creek rise in the Big Snowy and Judith mountains and unite below the McDonald Creek Divide to form Big Warm Spring Creek. The normal flow of Big Warm Spring Creek is influenced by one of the largest perennial springs in the state, which issues from the limestone rocks a few miles southeast of Lewistown. Its valley, enclosed in the gravel-capped benches and broken sandstone-capped uplands, is one-half to one mile wide between Lewistown and Hanover. Below Hanover the stream flows through a narrow valley below shaly bluffs and escarpments. The branches of this stream, such as Hanson, Castle, and Casino, are small perennial streams flowing through deep, narrow valleys in the foothill areas. The East Fork of Boyd Creek flows through a more open valley, which is about one-quarter mile wide in the lower foothills, Cottonwood and its branch, Beaver Creek, are fair-sized perennial streams meandering through valleys ranging from one-fourth to one-half mile wide and intrenched in the gravel-capped tablelands below the foothills.

Warm Spring Creek heading in the Judith Mountains, flows west and northwest and empties into the Judith River in the west central part of the county. The normal flow of this stream also is augmented by several large perennial springs. The valley of this stream widens out below Maiden Canyon, and in the vicinity of Brooks it is over one mile wide. West of Brooks a few miles, the stream enters an enclosed valley, which becomes more intrenched to the west.

Ming Coulee, Box Elder and Salt creek.—Ming Coulee, which rises on the western slopes of the north Moccasin Mountains and flows northwest through a sandstone canyon, has a continuous flow most of the year. Plum Creek, having a small perennial flow below these mountains, is intrenched in a more open valley north of Ming Coulee. Box Elder and Salt Creeks head on the northern slopes of these mountains, flow north and northwest through small enclosed valleys, and drain an area of rolling clay hills. The flow of these streams often becomes a chain of water holes along their lower courses late in the season.

Sage and Wolf creeks.—Sage Creek, uniting with the Judith River east of Deerfield, enters the county in a wide basin between the gravel-capped tablelands. It is an intermittent stream intrenched 10 to 15 feet in an alkali bottom below the eroded slopes of the gravel-capped benches and shaly ridges. Wolf Creek is a fair-sized perennial stream entering the county in a wide poorly drained, terraced valley. Four to 5 miles east of Denton the stream enters an intrenched narrow valley. Coyote Creek is another perennial stream meandering through a fairly wide valley below the gravelly slopes of high benches and entering Wolf Creek west of Denton. Dry Wolf Creek unites with Wolf Creek north of Hoosac and flows through an open valley below the gravel-capped benches. Its valley averages about one-quarter mile wide and is poorly drained.

Arrow Creek, which forms a part of the northwestern boundary of the county, heads in the Highwood Mountains. This stream carries a large volume of water during the spring and early summer months, but later on in the season its flow often shrinks into a number of stagnant water holes unless flushed out by local showers. Its valley is one-eighth to one-quarter mile wide and is intrenched 300 feet or more below the tops of the shaly breaks.

Coffee Creek heads in a heavy basin southwest of the town of Coffee Creek and flows northeast, entering Arrow Creek north of the Coffee Creek Bench. This stream has a continuous flow early in the season but later on its bed is likely to be dry except below perennial springs. The stream enters a small valley enclosed in shaly breaks, a few miles east of Coffee Creek.

HISTORICAL DEVELOPMENT

HISTORY

The area covered by Fergus County was largely the hunting grounds of such Indian tribes as the Gros Ventres, Crows and Sioux. Trapping and trading with the Indians were the chief industries in this part of the state up to the time of the discovery of gold in the area. Various expeditions, such as Hayden's, passed through the Judith Basin in the 50's and 60's to investigate the natural resources of the Northwest Territory. After the discovery of gold in western Montana, steamboats made regular trips up the Missouri River between St. Louis and Fort Benton, and during this time Cow Island and Carrol became important freight depots for the overland transfer of freight to western mining centers. Camp Lewis, located near the present site of Lewistown, was established in 1874, but its existence was brief because of Indian depredations. After the discovery of gold in Alpine Gulch and at Maiden and Warm Springs, Fort Maginnis was constructed in the summer of 1880 for the purpose of protecting miners from roving bands of Indians. The mining districts developed rapidly and flourished for a number of years. The Kootenai formation exposed in the foothills of the Big Snowy Mountains and on the divide east of Lewistown carries workable beds of excellent coal, and several mines were opened at an early date to meet local fuel and mining needs. Stockmen drove their herds into the area soon after Fort Maginnis was established.

SETTLEMENT

The Lewis and Clark Expedition passed through central Montana in 1804-1806, and from its memoirs a brief description is obtained of the area along the Missouri River. The area between the Yellowstone and Missouri rivers was visited rarely by white men—except for an occasional trapper and Indian trader—for many years after the Lewis and Clark expedition. Military forts were established in eastern Montana after the Custer Massacre to prevent further outbreaks among the Indians. After the Indians were confined to reservations, prospectors drifted into central Montana, and in 1880, gold was discovered in the Judith and Moccasin mountains. Stockmen followed the miners into the area and for a number of years mining and stock raising were the chief industries. In about 1906, dry land farming developed, resulting in a large part of the more desirable agricultural lands being placed under cultivation. The better grazing sections of the county were sectionized during the late 80's and 90's.

Time of Settlement.—The first permanent settlements in the county were made at mining camps and at way stations along

the routes of travel. Settlements were made at Moore, Lewistown, and Gilt Edge soon after Fort Maginnis was established in 1880. Stockmen located in the stream valleys as early as 1882 and 1883. The agricultural sections were not settled by the so-called dry-land farmer until about 1906.

Settlers.—The early miners and stockmen were largely of English, Scotch and German descent. The people attracted to the area during the so-called "dry-land movement" were largely native-born Americans who were drawn from the agricultural districts and industrial centers of the central states. A few localities were colonized during this time by people of alien extraction such as the Bohemians east and northeast of Roy and by immigrants from southern Europe who were employed in the mines. A small number of Chinese, Japanese, and negroes is found in the larger towns.

POPULATION

The county was rather thinly populated during the time stock raising and mining were the chief industries, but beginning with the settlement of the non-irrigated lands, the farm and urban populations increased rapidly. The census report for the year 1930 gives Fergus County a total population of 16,531 of which 115 were colored. The present farm population is placed at 7630.

TOWNS

Lewistown, the county seat and metropolis of the Judith Basin, is located in the southwestern part of the county on branch lines of the Great Northern and Milwaukee railways. It has a population of 5358 and serves a large farming and stock raising section. Its industries include cement and gypsum plants, brick-yards, flour mills, and several oil refineries. Denton with a population of 345 is located in a prosperous farming section in the northwestern part of the county. A number of other towns with populations ranging from 100 to 300 are located in different parts of the county and also serve farming and stock raising sections. Among the more important of these towns are Coffee Creek, Moore, Winifred, Grass Range, Hanover, Hilger, Suffolk, and Christina. Other trading and distributing points are located on the railways. Valentine and Battrick are inland trading centers. The larger towns have many of the modern municipal improvements, such as electric light, water, and sewerage connections. The educational facilities in the larger towns and in the more prosperous farming communities are up to state standards, but in some of the outlying farming and grazing districts the standards are below the state requirements. All the towns located on the railways are served by power and telephone companies.

TRANSPORTATION AND MARKETS

The Moccasin-Lewistown Branch of the Great Northern Railway, constructed in 1907, makes connection at Moccasin for Great Falls and Billings. The Great Falls-Harlowton Branch of the Chicago, Milwaukee, St. Paul and Pacific Railway was constructed through the county in 1912. This railway took over the Montana railway which built into Lewistown before 1907; and in 1915 and 1916, it constructed branch lines from Lewistown to Winifred, Roy, and Grass Range. These railways provide facilities for the shipment of freight to eastern and western markets such as Chicago, St. Paul, St. Louis, Portland, and Spokane. Great Falls and Butte are the chief markets for the more perishable farm products.

The state highways connecting Lewistown with Great Falls, Harlowton and Billings via Grass Range have oiled surfaces. The county roads between Lewistown and Winifred, Roy and Winnett have crushed gravel surfaces, which are maintained in fair condition. Other roads in the county are chiefly improved dirt roads, which become very dusty and rutty during the late summer and fall. The upland trails are passable most of the year.

CLIMATE

The climate of Fergus County ranges from semi-arid in the plains and on the lower tablelands to subhumid in the foothills and mountains. It is characterized below the mountains by a moderate rainfall, a comparatively low relative humidity, great temperature extremes and a large number of sunny days. The midsummer temperatures are not oppressive because of the low humidity, and the winter extremes, while severe, are not often accompanied by strong winds.

Tables 1 and 2 give the normal, monthly, seasonal and annual temperatures and precipitation at Denton, Lewistown, Pine Grove, and Valentine. These stations range in elevation from approximately 3000 feet above sea level at Valentine to over 5500 feet at Pine Grove. Denton and Lewistown have elevations of 3800 and 3900 feet respectively.

TEMPERATURE

The average annual temperature for the different stations ranges from 42.8° F. at Lewistown to 43.7° F. at Denton. January with averages of 16.6° to 22.6° is the coldest month and July with averages of 61.7° to 70.8° is the warmest. The greatest extremes in winter and summer temperatures are found at the lower elevations. Midsummer temperatures of over 100° have been reported at all the stations except at Pine Grove. The minimum winter temperatures range from -50° at Valentine to -42°

TABLE 1.—NORMAL, MONTHLY, SEASONAL AND ANNUAL TEMPERATURES AT DENTON
AND VALENTINE, WITH MAXIMUM AND MINIMUM FOR STATION

Month	Mean				Absolute maximum			
	Denton 1908-1922	Lewis-town 1896-1936	Valentine 1907-1936	Pine Grove 1912-1923	Denton	Lewis-town	Valentine	Pine Grove
December	24.2	24.5	19.6	22.7	63	71	62	57
January	20.0	21.7	16.6	22.6	60	60	62	60
February	21.9	21.1	19.5	20.7	62	66	65	62
Winter	22.0	22.4	18.6	22.0	63	71	65	62
March	31.3	31.5	30.9	25.2	72	77	80	68
April	43.6	42.2	43.8	35.5	86	86	89	74
May	51.2	50.5	53.5	47.6	96	93	97	90
Spring	42.0	41.4	42.4	36.1	96	93	97	90
June	61.0	58.8	63.7	55.6	100	105	104	96
July	66.8	65.4	70.8	61.7	102	105	106	95
August	64.2	63.6	68.3	57.6	106	98	109	99
Summer	64.0	62.6	67.6	58.3	106	105	109	99
September	56.1	53.5	56.8	50.8	94	98	98	85
October	49.8	44.8	45.3	40.7	88	92	92	85
November	34.3	32.7	31.6	32.5	72	81	77	67
Fall	46.7	43.6	44.6	41.3	94	98	98	85
Total	43.7	42.8	43.4	42.8	106	105	109	99

a Pine Grove. The average frost free period, varying with the location and elevation, dates from late May in the lower plains and early June in the foothills and mountains to the middle and last of September. Temperatures of 32° or lower have been reported at all the stations for every month in the year except for the month of July at Denton and Valentine. Small grains are usually seeded during the last of April in the lower plains and early in May on the higher tablelands and in the foothills. These grains are injured rarely by late spring frosts, but early fall frosts occasionally damage late seeded small grains on the high tablelands and in the irrigated districts.

PRECIPITATION

Precipitation in Fergus County is influenced by the elevation and proximity of the different mountain ranges. It normally increases with the elevation and is greatest on the northern and western slopes of the mountains and high divides. The lowest rainfall probably is received in the lower plains sections and on the gravel-capped tablelands east and south of the mountains. The average annual precipitation ranges from 12.57 inches at Valentine to 19.63 inches at Pine Grove. Lewistown reports an average of 18.40 inches and Denton, 13.74 inches. The total amount recorded for the driest year varies from 7.67 at Valentine to 12.74 inches at Pine Grove and for the wettest year from 18.85 inches at Denton to 27.50 inches at Pine Grove. Sixty-five to 75 per cent of the total annual precipitation is received during the period March 1 to September 1. The June rainfall in the Judith Basin averages higher than for any other locality in eastern Montana. The summer rainfall is received largely in local showers, often of a torrential character. The average annual snowfall ranges from 21.8 inches at Valentine to 104.5 inches at Pine Grove. The average in the Judith Basin is between 5 and 6 feet, but it rarely accumulates on the tablelands to any great depth because of warm winds during the winter months.

WIND

The area is subject to brisk westerly winds which are usually stronger and more severe during the late winter and early spring, and in dry seasons may cause considerable soil drifting and damage to fall and early spring seeded grains. Chinooks or warm winds are characteristic of this part of the state during the winter months. Hot winds occur occasionally during dry seasons and have caused serious crop losses in the lower plains. The normal evaporation from a free water surface at the Judith Basin Branch Station near Moccasin between April 1 and October 1 is 33.33 inches. Hail storms of more or less severity occur occasionally during the summer months. (See tables 1 and 2.)

TABLE 2.—NORMAL, MONTHLY, SEASONAL AND ANNUAL PRECIPITATION AT DENTON
AND VALENTINE, WITH MAXIMUM AND MINIMUM TEMPERATURES AND SNOWFALL

	Mean					Total amount driest year					Total amount w year				
	Denton 1908-1922	Lewisstown 1896-1936	Valentine 1907-1933	Pine Grove 1912-1923		Denton 1919	Lewisstown 1900	Valentine 1917	Pine Grove 1919		Denton 1916	Lewisstown 1909	Valentine		
Month															
December	0.46	0.84	0.40	0.97	0.88	0.90	0.62	0.32	1.35	1.21	0.02				
January	0.72	0.74	0.51	1.23	0.36	0.59	0.12	0.33	0.96	1.25	2.28				
February	0.33	0.74	0.38	0.72	0.26	0.50	0.74	0.40	0.19	0.10	0.02				
Winter	1.51	2.32	1.29	2.92	1.30	1.99	1.48	1.05	2.50	2.56	2.32				
March	0.48	1.04	0.55	1.22	0.37	0.16	0.07	1.02	0.05	1.27	0.56				
April	0.91	1.27	0.80	1.51	0.06	0.36	0.27	0.25	0.93	1.19	0.41				
May	1.85	2.98	2.18	3.37	0.32	0.20	2.15	1.22	2.45	2.50	2.60				
Spring	3.24	5.29	3.53	6.10	0.75	0.72	2.49	2.49	3.43	4.96	3.57				
June	3.09	3.64	3.00	3.75	1.60	1.50	1.03	1.15	5.90	4.86	4.89				
July	1.85	2.26	1.58	3.06	0.72	0.55	0.53	1.62	3.09	4.20	4.98				
August	1.00	1.43	1.19	1.30	0.12	4.20	0.35	1.34	0.53	2.73	1.13				
Summer	5.94	7.33	5.77	8.11	2.44	6.25	1.91	4.11	9.52	11.79	10.80				
September	1.76	1.63	0.95	1.79	1.98	0.80	1.50	2.35	1.88	4.23	0.85				
October	1.10	1.24	0.72	1.10	1.03	1.00	0.29	2.11	0.78	0.50	1.61				
November	0.61	0.63	0.81	0.61	0.35	0.32	0.00	0.63	0.74	0.91	0.74				
Fall	3.47	3.50	2.48	3.50	3.36	2.12	1.79	5.09	3.40	5.64	3.20				
Total	13.74	18.40	12.57	19.63	7.85	11.08	7.67	12.74	18.85	24.95	19.89				

DESCRIPTION OF SOILS*

Fergus County, consisting of rolling plains, gravel-capped tablelands, foothills, and mountains has a variety of soils varying with the elevation, topography, location, and nature of the parent material. The mature soils or those with distinct horizons, classified according to color belong to several color groups; namely, grayish-brown, dark grayish-brown, very dark grayish-brown, black, and in the higher mountain areas probably some brown and gray forested soils. The soils on the limestone gravel-capped tablelands in the Judith Basin have rather dark colored surface soils for the depth of horizons. The grayish-brown soils with carbonate zones 5 to 8 inches below the surface cover the rolling plains in the northeastern part of the county. The dark grayish-brown soils with carbonate zones below 8 to 15 inches occur chiefly on the gravel-capped tablelands in the west central part and on the divides and benches in the east central part. Very dark grayish-brown soils with carbonate zones ranging from 15 to 20 inches or more below the surface occur on the higher tablelands and in the mountain foothills. Black soils without carbonate zones are found in the higher foothills and on the mountain slopes. Gray or immature soils without distinct horizons cover the breaks of such streams as the Missouri and Judith rivers and Arrow Creek and the rolling clay hills in the northeastern part of the county. Grayish-brown and dark grayish-brown soils have developed under a short grass cover, a moderately low rainfall, and a wide range in summer and winter temperatures. Black soils have developed under a tall grass cover, greater rainfall, lower mean annual temperatures and short growing seasons. The very dark grayish-brown soils have developed under conditions intermediate between these two groups. The farm lands of Fergus County are confined largely to those areas covered with the dark grayish-brown and very dark grayish-brown soils; and the better grazing lands, to the darker colored groups such as the very dark grayish-brown and black soil areas.

The soils developed over calcareous sandstone and shales and over sedimentary crystalline rocks in Fergus County are grouped in five series; namely, Bainville, Jordan, Morton, Teton, and Adel. These series in the order named have respectively

*Preliminary soil reports of each county surveyed are being published by the Montana Agricultural Experiment Station. A final report covering a group of counties in central Montana will be published by the United States Bureau of Chemistry and Soils of the United States Department of Agriculture. The soil correlations made in Fergus County are tentative and have not been approved by the Soil Correlation Committee of the Bureau of Chemistry and Soils. Therefore, changes in names and regrouping of soils may be made by the correlation committee in the final report.

darker colored surface soils and deeper horizons. The gray to grayish-brown soils of the Bainville series, effervescing with acid at or within a few inches of the surface and often having the stratification of the parent material within a few feet of the surface, cover (1) broken sandstone-capped areas in the eastern part of the county, (2) the high divide above the breaks of the Missouri River, and (3) the broken sandstone escarpments of gravel-capped benches in the northwestern part. The soils of the Bainville series are not under cultivation and have a low livestock carrying capacity. The grayish-brown soils of the Jordan series with carbonate zones within 6 to 8 inches of the surface occur on the more gentle slopes of sandstone ridges in the east central and north central parts. The Jordan soils have a low productivity but have a fair livestock carrying capacity. The more mature dark grayish-brown soils of the Morton series with carbonate zones below 8 to 15 inches are found chiefly in the southeastern part and in the sandstone-capped area north and northwest of the mountains. The tillable phases of this series are under cultivation and have a fair productivity. The land has a fair grass cover and a good livestock carrying capacity. The very dark grayish-brown soils of the Teton series with carbonate zones below 15 to 30 inches occur on the higher divides and in the lower mountain foothills in the central and southeastern parts. The tracts are quite stony and lie at a fair elevation for general farming but have a high productivity and a high livestock carrying capacity. The very dark brown almost black soils of the Adel series, without carbonate zones, cover the higher foothills and mountain slopes and parks. Tracts covered with these soils are used chiefly for summer grazing and for the production of early maturing forage crops. The land has a high livestock carrying capacity during the 6 to 7 months the area is free from snow.

The soils developed over the Kootenai sandstones and shales in the central part of the county often have distinctive red colors. These dark reddish-brown and very dark reddish-brown soils with distinct gray shades are grouped according to development in the Morton and Teton series and are designated on the soil map as a red phase of these series. The productivity and livestock carrying capacity of these red soils are about the same as for the related soils of the Morton and Teton series.

The soils developed largely over non-calcareous shales are grouped in six series; namely, Lismas, Pierre, Gerhard, Marias, Winifred, and Power. These series also have respectively deeper horizons and darker colored surface soils. The immature gray soils of the Lismas series cover barren shale outcrops not classified as badlands in different parts of the county. The land has a

very low livestock carrying capacity. The gray soils of the Pierre series, showing a slight soil development with calcareous surface mulches and cloddy structureless clay surface and subsoils, occur in the northern and northeastern parts. The land covered with black sage is not under cultivation and also has a low livestock carrying capacity. Areas covered with timber are designated on the soil map as a timbered phase of this series. The dull grayish-brown soils of the Gerhard series with carbonate zones 3 to 7 inches below the surface are associated with the Pierre soils in the northern and northeastern sections of the county. The soils of this series, also covered with black sage, are not under cultivation except along Dog Creek where they grade into the Winifred soils and have a low livestock carrying capacity. The dark grayish-brown soils of the Winifred series with carbonate zones 6 to 15 inches below the surface cover large tracts in the north central part of the county. The tillable phases of this series have been placed under cultivation, but the yields of small grains average low in comparison with the better soils in the county. The land is well grassed over and has a good livestock carrying capacity. The very dark brown soils of the Power series occur chiefly in the northwestern and north central parts of the county. These soils are under cultivation and have a fair livestock carrying capacity. The surface soils on the tracts in the south central part of the county are quite dark and are designated as a dark phase of this series on the soil map. The grayish-brown to dark grayish-brown soils of the Marias series, effervescing with acid in all sections, cover isolated tracts in the northern and northeastern parts of the county. These soils produce fair crops on summer fallowed land and have a fair livestock carrying capacity. Various phases of these soil series are designated on the soil map to indicate the soil development, characteristics, and productivity.

The Phillips series includes a group of soils characterized by the so-called "scab" or "blow-out holes". Two phases are designated on the soil map, (1) dark grayish-brown soils covering undulating upland tracts, and (2) grayish-brown soils, occurring chiefly in poorly drained basins. Soils of this series occur chiefly in the northern and eastern parts of the county and have a low livestock carrying capacity.

Several dark colored soil series, such as the Zortman and Blaine, occur on high benches and on the broken slopes of the mountains. The black soils of the Zortman series, developed over limestone in the higher foothills of the Big Snowy Mountains, are quite stony and shallow, and the tracts are used chiefly for summer grazing. The dark grayish-brown to very dark grayish-brown soils of the Blaine series, developed over igneous outcrops and outwash, occur chiefly in the foothills and on the mountain

slopes of the Moccasin and Judith mountains. The less stony and broken tracts are locally under cultivation and have a high livestock carrying capacity during the 6 to 7 months the area is open for grazing.

The soils developed on limestone gravel-capped tablelands are grouped in the Tyler, Moccasin, Danvers and Denton series. The grayish-brown soils of the Tyler series with semi-cemented carbonate zones below 7 to 10 inches occur on benches in the southeastern and southwestern parts of the county. The tracts are quite stony and gravelly and are used chiefly for the grazing of livestock. The native grass lands have a fair livestock carrying capacity. The Moccasin series comprises a group of undifferentiated dark grayish-brown and very dark grayish-brown soils with semi-consolidated gravelly carbonate zones below 10 to 15 inches or more. The soils of this series cover the gravelly tablelands in the west central part and the deeper and less gravelly phases are among the most productive soils in the area. The native grass lands have a good grass cover and a high livestock carrying capacity. The soils of the Danvers series, developed over heavy wind-blown and wash material, underlaid with limestone gravel at various depths, have about the same development as the soils of the Moccasin series. Soils of this series occur on benches in the west central and northwestern parts and are among the more productive winter wheat soils in the area. The soils of the Denton series occurring in basins and on undulating slopes along Wolf Creek differ from the Danvers in having some limestone gravel in the surface soils and less gravelly stratified subsoils. The tracts covering some of the best farm land in the county have a good livestock carrying capacity. Various phases of these soils also are designated on the soil map.

The Lloyd series includes another group of undifferentiated dark grayish-brown and very dark grayish-brown soils developed on high benches and on mountain slopes covered with igneous rock and gravel similar to that found in the Moccasin and Judith mountains. The larger tracts in the vicinity of the mountains are quite stony and are used largely for the grazing of livestock. Land cleared of rock has a good productive capacity. The soils on the lower benches, designated as a dark brown phase of this series on the soil map, are under cultivation and have a good livestock carrying capacity where the land is not too gravelly.

The soils on the high benches, characterized by scab spots, are grouped in the Gilt Edge and Box Elder series. The Gilt Edge series includes a group of dark grayish-brown soils found on high benches in the east central part of the county. The tracts covered chiefly with black sage have a low livestock carrying capacity. The Box Elder series includes a group of grayish-brown

to dark grayish-brown soils occurring on secondary benches in such stream valleys as Armells Creek. The tracts covered chiefly with black sage and grease-wood, also have a low livestock carrying capacity.

The Lowry series includes a group of undifferentiated grayish-brown to dark grayish-brown soils developed over shallow gravel deposits in the uplands and over gravelly wash on the slopes of the benchlands. The tracts are locally under cultivation. The land has a fair grass cover and a good livestock carrying capacity. Several phases of this series are designated on the soil map.

Soils developed over old stream deposits in the valleys of the larger streams are grouped in the following series: Beaverton, Orman, Cheyenne, and Wade. The Beaverton series includes a group of dark grayish-brown soils developed on high terraces or low benches along some of the streams such as Dog Creek. The less gravelly tracts are under cultivation and have a fair livestock carrying capacity. Dark grayish-brown heavy soils, effervescing with acid at 6 to 10 inches and having alkali impregnated subsoils, are grouped in the Orman series. These soils are not under cultivation and have a low livestock carrying capacity. The Cheyenne series includes a group of dark grayish-brown to very dark grayish-brown soils, developed on secondary benches along the streams in the west central part of the county. The tracts are under cultivation and have a fair productivity where the land is not too gravelly and sandy. The Wade series includes a group of very dark grayish-brown soils, with carbonate zones below 10 inches or more, occurring in the upper part of such stream valleys as Warm Spring, Big Springs, Wolf, and other creeks. The better drained phases have a high productive capacity and a high livestock carrying capacity.

The soils developed over recent stream deposits are grouped in the Chouteau and Laurel series. The Chouteau series includes a group of undifferentiated black, poorly drained soils without distinct horizons covering the stream valleys in the mountains and foothills. Locally the tracts are valuable wild hay lands. The Laurel series includes another group of undifferentiated gray calcareous soils, also without distinct horizons, occurring in the stream valleys at the lower elevations. The subirrigated and irrigated lands are under cultivation along the streams. Most of the valleys have a low livestock carrying capacity.

Barren rock outcrops, badlands, mountains, stony outwashes and swamps are designated as physiographic features on the soil map. Badlands covering a large area in the northern part of the county are highly timbered and have a very low livestock carrying capacity.

SOILS OF FERGUS COUNTY

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TABLE 3.—AREA AND PROPORTIONATE EXTENT OF EACH SOIL TYPE
MAPPED IN FERGUS COUNTY

Soil series and types	Area (In Square Miles)	Per cent of county	Topography	
			Level to sharply rolling	Sharply rolling
Adel Series				
Adel Loams	37.5	0.9	29.8	7.7
Adel Stony Loams	23.4	0.5	12.3	11.1
Bainville Series				
Bainville Loams	143.7	3.3	8.3	135.4
Beaverton Series				
Beaverton Loams	1.6	0.0	1.6	0.0
Blaine Series				
Blaine Loams	83.5	1.9	62.2	21.3
Blaine Stony Loams	79.0	1.8	16.6	62.4
Box Elder Series				
Box Elder Loams	16.6	0.3	16.6	0.0
Box Elder Silty Clay Loams	3.3	0.1	3.3	0.0
Cheyenne Series				
Cheyenne Gravelly Sandy Loams	29.7	0.6	29.7	0.0
Cheyenne Sandy Loams—dark phase	8.4	0.2	8.4	0.0
Cheyenne Gravelly Loams	8.4	0.2	8.4	0.0
Chouteau Series				
Chouteau Loams	121.8	2.8	121.8	0.0
Danvers Series				
Danvers Loams	29.0	0.7	29.0	0.0
Danvers Sandy Loams	3.8	0.1	3.8	0.0
Danvers Silty Clay Loams	83.2	1.9	83.2	0.0
Denton Series				
Denton Loams	7.5	0.2	7.5	0.0
Denton Gravelly Silty Clay Loams	18.5	0.4	18.5	0.0
Denton Silty Loams	8.0	0.2	8.0	0.0
Gerhard Series				
Gerhard Clay Loams	98.7	2.0	68.1	30.6
Gerhard Clay Loams—deep phase	40.1	0.9	29.7	10.4
Gerhard Clay Loams— shallow phase	138.6	3.2	138.6	0.0
Gilt Edge Series				
Gilt Edge Gravelly Loams	12.0	0.3	12.0	0.0
Jordan Series				
Jordan Loams	58.1	1.3	35.1	23.0
Jordan Sandy Loams	30.6	0.7	30.6	0.0
Jordan Silty Clay Loams	29.7	0.7	29.7	0.0
Laurel Series				
Laurel Loams	103.2	2.4	103.2	0.0
Laurel Loams—Alkali Phase	85.1	2.0	85.1	0.0
Lismas Series				
Lismas Clay Loams	64.8	1.5	0.0	64.8
Lloyd Series				
Lloyd Gravelly Loams	19.7	0.4	15.2	4.5
Lloyd Gravelly Loams— dark brown phase	82.3	1.9	82.3	0.0
Lloyd Gravelly Silty Clay Loams— dark brown phase	22.5	0.5	19.6	2.9
Lloyd Stony Loams	21.7	0.5	21.7	0.0
Lowry Series				
Lowry Loams	66.5	1.5	39.1	27.4
Lowry Gravelly Loams—dark phase	95.6	2.2	57.0	38.6

TABLE 3.—AREA AND PROPORTIONATE EXTENT OF EACH SOIL TYPE
MAPPED IN FERGUS COUNTY—(Continued)

Soil series and types	Area (In Square Miles)	Per cent of county	Topography	
			Level to sharply rolling	Sharply rolling
Marias Series				
Marias Clay Loams	20.2	0.5	20.2	0.0
Moccasin Series				
Moccasin Gravelly Loams	86.5	2.1	86.5	0.0
Moccasin Gravelly Loams— dark phase	10.2	0.2	10.2	0.0
Moccasin Gravelly Loams— shallow phase	10.3	0.2	10.3	0.0
Moccasin Gravelly Sandy Loams	16.4	0.4	16.4	0.0
Moccasin Gravelly Sandy Loams— shallow phase	13.6	0.3	13.6	0.0
Moccasin Gravelly Silty Clay Loams	17.2	0.4	17.2	0.0
Moccasin Loams—dark phase	46.1	1.1	46.1	0.0
Moccasin Stony Loams	6.8	0.2	6.8	0.0
Morton Series				
Morton Loams	37.2	0.9	37.2	0.0
Morton Loams—shallow phase	52.2	1.2	52.2	0.0
Morton Loams—shallow red phase	21.6	0.5	21.6	0.0
Morton Sandy Loams	21.9	0.5	21.9	0.0
Morton Silty Clay Loams	24.3	0.6	21.6	2.7
Morton Silty Clay Loams— gravelly phase	6.2	0.1	6.2	0.0
Morton Silty Clay Loams— shallow phase	32.2	0.8	32.2	0.0
Morton Stony Loams	89.5	2.1	64.7	24.8
Morton Stony Loams— timbered phase	80.2	1.9	0.0	80.2
Orman Series				
Orman Clay Loams	10.0	0.2	10.0	0.0
Pierre Series				
Pierre Clay Loams	158.6	3.7	111.2	47.4
Pierre Clay Loams—level phase	25.8	0.6	25.8	0.0
Pierre Clay Loams—timbered phase	277.4	6.4	0.0	277.4
Phillips Series				
Phillips Loams	45.0	1.0	45.0	0.0
Power Series				
Power Clay Loams	60.6	1.4	52.5	8.1
Power Clay Loams—dark phase	17.4	0.4	10.9	6.5
Teton Series				
Teton Loams	61.4	1.4	35.7	25.7
Teton Loams—shallow phase	16.9	0.4	16.9	0.0
Teton Sandy Loams	7.4	0.2	7.4	0.0
Teton Sandy Loams—red phase	15.0	0.3	14.0	1.0
Teton Stony Loams	92.5	2.1	6.1	86.4
Teton Stony Loams— timbered phase	123.6	2.9	0.0	123.6
Tyler Series				
Tyler Gravelly Loams	14.7	0.3	14.7	0.0
Tyler Gravelly Loams— cemented phase	4.7	0.1	4.7	0.0
Tyler Stony Loams	13.0	0.3	13.0	0.0
Tyler Stony Loams— timbered phase	11.4	0.3	0.0	11.4

TABLE 3.—AREA AND PROPORTIONATE EXTENT OF EACH SOIL TYPE MAPPED IN FERGUS COUNTY—(Continued)

Soil series and types	Area (In Square Miles)	Per cent of county	Topography	
			Level to sharply rolling	Sharply rolling
Wade Series				
Wade Loams	84.4	1.9	84.4	0.0
Wade Clay Loams	3.2	0.1	3.2	0.0
Winifred Series				
Winifred Clay Loams	211.3	4.9	128.3	83.0
Winifred Clay Loams— gravelly phase	25.2	0.6	7.0	18.2
Zortman Series				
Zortman Stony Loams	2.5	0.1	0.0	2.5
Physiographic Features				
Badlands	291.5	6.7	0.0	291.5
Forests	176.5	4.3	0.0	176.5
Mountains	298.5	6.9	0.0	298.5
Rock Outcrops	8.7	0.2	0.0	8.7
Swamps	1.5	0.0	1.5	0.0

The soils in Fergus County are grouped into twenty-eight soil series and seventy-four soil types and phases. Table 3 gives the area in square miles of each soil type and physiographic feature and also the area of each type unsuitable to agriculture because of its broken topography.

The soil map is designed to show the location and extent of the various kinds of soil in the area. It is based on the physical properties such as color, texture, structure, thickness, and relative position of the different horizons or layers found in the soil under field conditions. These horizons (observed in road cuts) are the result of the natural soil forming processes influenced by climate, topography, drainage, vegetation, erosion, etc. Soils having the same number, arrangement, and similar character of horizons are divided into large groups known as the "soil series", which are further divided into "soil types" on the basis of the proportion of sand, silt, and clay in the surface layers. Reconnaissance soil surveys deal largely with the identification and isolation of the larger soil groups. Soil types are not readily isolated in traversing an area at intervals of 2 miles and on the soil map only the most prevalent types such as sandy loams, loams, and clay loams of each series are shown. Therefore, each soil type as mapped may contain tracts of heavier or lighter soils and in some cases, isolated tracts of other soil series. Local variations in the character of each soil type with respect to color, depth, and stoniness are shown as "phases". The soil map, together with the following

soil descriptions is the only available source of information on the soils of Fergus County at the present time. This information, although based on a soil reconnaissance, is of value in planning sound agriculture programs for the area. (See table 3.)

BAINVILLE LOAMS

Bainville loams have loose shallow grayish-brown fine sandy mulches on the surface. The shallow gray to grayish-brown humus-bearing layers are structureless loams and sandy loams effervescing with acid at or within a few inches of the surface. The lower soil depths are rusty colored loams and sandy loams having the structure and stratification of the parent material. Calcareous sandstones outcrop and underlie the tracts at varying depths. The soils on the sandstone ridges above the breaks of the Missouri and Judith rivers have a fair development, where snow accumulates in basins during the winter months. Shales outcrop occasionally and give rise to immature silty clay loams, often impregnated with alkali. These loams cover ridges in the north central part, escarpments or benches in the northwestern part, and broken sandstone-capped areas along Blood Creek in the east central part of the county. They are classified as non-tillable grazing land on the land classification map and cover 143.7 square miles of which 135.4 square miles are too broken for cultivation.

Utilization.—Bainville loams are utilized chiefly for the grazing of livestock. The more level phases were placed under cultivation at the time of settlement of the dry-land farming areas, but the soils were too low in productivity for farming and were abandoned. In 1930, less than 5 per cent of the tillable land was under cultivation. The cropped acreage, devoted chiefly to forage and feed crops, was distributed largely in small tracts on the lower slopes of the sandstone ridges and in basins at the head of drainage courses. The yields of spring wheat, grown occasionally on summer fallowed land, average less than 10 bushels per acre. Soil drifting is difficult to control on the more exposed slopes.

Vegetation.*—Grama grass (*Bouteloua gracilis*) and its associated species such as the sedge nigger wool (*Carex filifolia*) form

*The vegetation is discussed from the standpoint of the economic value of the different species of grasses and shrubs in their relationship to the livestock carrying capacity of the different soil types. The abundance and character of the vegetation is influenced by such adversities as drought, over-grazing, etc. The prevalence of such grasses as June grass, needle grass, and such shrubs as silver sage indicates adverse climatic conditions or poor range management. The carrying capacity of the range for any particular season, therefore, depends upon a number of factors. The acreage given for carrying a steer through a 10 months grazing season is an estimate made by experienced stockmen in the area. In determining the carrying capacity for sheep, 4 to 6 ewes and their lambs are considered the equivalent of one steer.

the chief cover on the Bainville loams. Other grasses, such as needle grass (*Stipa comata*) and June grass (*Koeleria cristata*) are more or less prevalent, especially in the overgrazed sections. Various shrubs, such as silver sage (*Artemisa frigida*), gum weed (*Grindelia squarrosa*), and match weed (*Gutierrezia sarothrae*) are abundant but have no economic value as forage plants except for sheep. A light stand of yellow pine is found on the broken ridges above the Missouri and Judith rivers and in the areas north of Valentine in the east central part of the county. The forage on 30 to 40 acres of the more level grass lands and 40 to 50 acres of the more broken and timbered phases would carry a steer through a 10 months grazing season.

JORDAN LOAMS

Soils having a somewhat better development than the Bainville loams in the less broken and isolated areas were differentiated and grouped in the Jordan series. The Jordan loams differ chiefly from the Bainville loams in having poorly developed columnar structured grayish-brown to brown surface soils and fairly well developed gray carbonate zones at 3 to 8 inches below the surface. The lower depths are usually compact, yellowish to grayish-brown loams and sandy loams, occasionally having the structure and stratification of the parent material. Locally the wash from the sandstone ridges overlies at comparatively shallow depths residual material derived from shales, and the subsoils are compact grayish olive-brown silty clays and clays.

The Jordan loams occur on gently sloping tracts below sandstone ridges in the north central and eastern parts of the county and also cover the broken slopes or breaks of the Judith River and other streams in the northwestern part. These loams, classified as farming-grazing land, grazing land, and nontillable grazing land on the land classification map, cover 58.1 square miles of which 35.1 square miles have a topography suitable for cultivation.

Utilization.—The Jordan loams were settled and placed under cultivation after the Enlarged Homestead Act came into effect in 1913. These loams produced fair crops for a few years, but during the drought of 1918-1921 a large cropped acreage was abandoned. In 1930 the cropped acreage, amounting to approximately 30 per cent of the tillable phase was confined largely to isolated tracts in the north central part of the county. The small grains were grown for hay, and such cash crops as spring and winter wheat were the principal crops grown on the tracts. Stock raising is the chief enterprise on most of the farms with the cash crops

of secondary importance. The surface acre foot of soil contains 2400 to 3000 pounds of nitrogen* and 1800 pounds of phosphorus. The yield of spring wheat on land occasionally summer fallowed averages between 7 and 10 bushels per acre with occasional yields of 15 to 20 bushels per acre in favorable seasons. Soil drifting is difficult to control on many of the tracts.

Vegetation.—Grama grass and nigger wool form the chief cover on the more gently rolling phases of the Jordan loams. A light stand of yellow pine covers the breaks of the Judith River. The forage on 25 to 30 acres of native grass land and 30 to 45 acres of the timbered phase would carry a steer through a 10 months grazing season on most of the tracts.

Jordan Sandy Loams

The soils grouped under the Jordan sandy loams range in texture from fine to coarse sandy loams. The fine sandy loams, developed over wash in the valley of Blood Creek west of Valentine, have fine sandy surface mulches, grayish-brown fine sandy humus-bearing layers and gray sandy carbonate zones at 3 to 6 inches below the surface. The lower soil depths are compact, permeable yellowish-brown fine sands of fair depth with an occasional stratum of coarser or finer sandy material. The coarse sandy and fine sandy loams on the upland tracts between the Judith River and Dog Creek have somewhat deeper and darker colored humus-bearing layers. The sandy subsoils often have the structure and stratification of the parent material. These sandy loams cover gentle slopes below sandstone ridges in the valley of Blood Creek and isolated upland tracts in the northwestern and north central parts of the county. They are classified as farming land and grazing forage land on the land classification map and cover 30.6 square miles, nearly all of which is tillable.

Utilization.—The sandy loams were placed under cultivation about the same time as the loams and have been devoted largely to the production of spring and winter wheat. The cropped acreage devoted to small grains for winter forage has increased the past few years. In 1930, about one-half of the cropped acreage amounting to approximately 30 per cent of the total area, was found in the valley of Blood Creek. The amount of nitrogen and phosphorus in the surface acre foot of soil is about the same as for the loams. The yields of spring wheat on summer fallowed land average between 7 and 9 bushels on the more sandy loams and 8 to 12 bushels per acre on the fine sandy loams. Fair yields are reported occasionally on tracts located below crests of low ridges, where the snow accumulates during the winter months

*Soil analysis made by the Chemistry Department, Montana Agricultural Experiment Station.

or where the land receives runoff from higher levels. The soils drift unless they have a protective vegetative cover.

Vegetation.—Gramma grass and nigger wool predominate, and the forage on 20 to 30 acres of native grass land would carry a steer through a 10 months grazing season.

Jordan Silty Clay Loams

The Jordan silty clay loams, occurring chiefly on gentle slopes below ridges of Claggett shales in the north central part of the county, have shallow, fine-grained, silty clay surface mulches and friable grayish-brown silty clay humus-bearing layers, effervescing with acid at 3 to 5 inches below the surface. The lower depths are compact grayish olive-brown silty clays, occasionally having zones of alkali. These heavy loams, classified chiefly as grazing land on the land classification map cover 29.7 square miles, nearly all of which is tillable.

Utilization.—The Jordan silty clay loams are located largely in stock raising sections of the county and are devoted chiefly to the production of forage crops such as the small grains grown for hay. Approximately 20 per cent of the area was under cultivation in 1930. The surface acre foot of soil contains about the same amount of nitrogen and a somewhat higher content of phosphorus than the loams. The yields of spring wheat on these heavy loams are not as dependable nor as consistent as on the loams and sandy loams, but with occasional yields of 20 bushels or more in favorable seasons the yields average almost as high. The soils drift on the more exposed tracts.

Vegetation.—Western wheatgrass (*Agropyron smithii*) and grama grass, associated with black sage form the chief cover on the tracts, and the forage on 25 to 30 acres of native grass land would carry a steer through a 10 months grazing season.

MORTON LOAMS

The surface one to 2 inches of the Morton loams is a laminated fine sandy mulch. The humus-bearing layers are friable, columnar structured, dark grayish-brown to dark brown loams 5 to 7 inches thick. The subsurface layers, also having a columnar structure, are somewhat heavier in texture and more compact on the more mature phases. The gray to grayish-brown silt to silty clay carbonate zone is well developed at 7 to 15 inches and grades into stratified sandy, silty, material, or into lime-coated sandstone fragments at 24 to 42 inches or more. The deeper and darker colored surface soils occur on a rolling divide north of the Moccasin Mountains and in a basin south of a gravel-capped bench in the vicinity of Grass Range. Shallow loams and silt loams, with fairly dark colored surface soils, occur on the divide west of Winifred. Stratified shaly sandstones outcrop on the

slopes of drainage basins and underlie the tracts at comparatively shallow depths.

The Morton loams occur (1) on gentle slopes below sandstone escarpments in the west central part of the county, (2) on rolling divides north and west of the Moccasin Mountains, and (3) in a basin south of Grass Range. These loams, classified as farming land and farming grazing land on the land classification map, cover 37.2 square miles.

Utilization.—The Morton loams were placed under cultivation in the western half of the county soon after the railway entered Lewistown, but the more remote tracts were not settled and developed until after 1913. Exclusive small grain growing was carried on for some years after the land was broken out, but with declining small grain yields and prices, stock raising was combined with grain growing on many of the farms and a fair acreage devoted to forage crops. In 1930, approximately 85 per cent of the area was in crops and summer fallowed land. Continuous cropping to such cash crops as spring and winter wheat was carried on until the land became foul, when a clean summer fallow was introduced every second or third year to control weeds. The forage crops consist chiefly of alfalfa, sweet clover and the small grains—such as oats and barley—grown for hay. The surface acre foot of soil contains 3500 to 5000 pounds of nitrogen and 1500 to 2000 pounds of phosphorus. The yields of spring wheat on the tracts north of the Moccasin Mountains and in the basin south of Grass Range, average between 15 and 20 bushels per acre on summer fallowed land with occasional yields of 25 bushels or more in favorable seasons. The yields of spring wheat on the more shallow phases west of Winifred average between 10 and 12 bushels per acre. Drifting of soil on summer fallowed land has been difficult to control during recent years, and in the older cropped sections the yields of small grain have been declining.

Vegetation.—Western wheat grass and grama grass form the chief cover on the Morton loams. The forage on 20 to 25 acres of native grass land would carry a steer through a 10 months grazing season.

Morton Loams — Shallow Phase

The shallow phase of the Morton loams includes a group of undifferentiated dark grayish-brown soils underlaid at varying depths with disintegrated sandstone. In the southeastern part of the county the soils underlaid at comparatively shallow depths with disintegrated sandstones have rather dark colored surface mulches and humus-bearing layers ranging in texture from loams to sandy loams. Coarse sandy loams predominate on the tracts bordering the timbered phase of the Teton loams in

T. 13 and 14 N., R. 22 E. The soils, developed over the Kootenai sandstones in the southeastern part of the county, often have distinctive red colors. Other tracts of these shallow loams, such as found along Warm Springs and Armells creeks, have rather shallow horizons, and are locally underlaid with distingrated sandstone at fair depths. This phase occurs on isolated tracts of gently sloping and rolling land in the southeastern and northwestern parts of the county. It is classified as non-tillable grazing land on the land classification map and covers 52.2 square miles.

Utilization.—Stockraising is the chief enterprise on most of the farms located on these shallow loams and the land under cultivation is devoted largely to forage crops. The cropped acreage in 1930 was approximately 12 per cent. The surface acre foot of soil on the tracts in the southeastern part of the county contains 3000 to 4500 pounds of nitrogen and 1300 to 2000 pounds of phosphorus. The yields of spring wheat varying with the soil depth and location are quite variable on the different tracts and range from 8 to 12 bushels per acre on land occasionally summer fallowed.

Vegetation.—The tall bunch grasses form the chief cover on these shallow loams in the southeastern part of the county and western wheat grass and grama grass on the tracts in the northwestern part. The forage on 20 to 25 acres of native grass land would carry a steer through the 9 to 10 months the tracts are open for grazing.

Morton Loams — Shallow Red Phase

The shallow red phase of the Morton loams, developed over the Kootenai sandstones, differs from the shallow phase of the Morton loams in having red colors in all sections. The tracts are underlaid at comparatively shallow depths with red sandstone. Along Pike Creek red shales outcrop, and the red soils developed over them and from wash have a silty clay texture and a profile similar to the Morton silty clay loams.

The shallow red phase of the Morton loams occurs on the MacDonald Creek Divide and on isolated tracts in the southeastern part of the county. This phase, classified as farming grazing land on the land classification map, covers 21.6 square miles of which approximately 20 per cent was under cultivation in 1930. These red loams have about the same productivity and livestock carrying capacity as the Morton loams found in the vicinity of the tracts.

Morton Sandy Loams

The surface soils of the Morton sandy loams are dark grayish-brown sandy loams and coarse sandy loams underlaid with a compact sandy subsurface layer. The heavier textured gray car-

bonate zone below 11 to 20 inches grades into compact yellowish-brown sands or into fragmentary sandstones at 30 to 42 inches or more. Sandy loams of medium coarse texture predominate on the tracts along Ming Coulee and between the Judith River and Dry Wolf Creek. Coarse sandy loams cover largely the tracts east of Black Butte and the tracts in the southeastern part of the county. These sandy loams occur on rolling slopes and on undulating upland tracts in the west central, east central, and southeastern parts of the county. They are classified largely as farming grazing land on the land classification map and cover 21.9 square miles, nearly all of which is tillable.

Utilization.—The Morton sandy loams are well under cultivation and devoted chiefly to the production of spring and winter wheat. In 1930, 80 per cent of the area was in crops. The surface acre foot of soil contains 2000 to 3000 pounds of nitrogen and 1500 to 2000 pounds of phosphorus. The yields of spring wheat on the medium coarse sandy loams and on the sandy loams average between 8 and 12 bushels per acre. Summer fallowing of land is not generally practiced on the sandy loams because of soil drifting and also because of the small increase in small grain yields on summer fallowed land over land occasionally summer fallowed to control weeds.

Vegetation.—Grama grass, nigger wool, and the tall grasses adapted to droughty conditions form the chief cover on the sandy loams. The forage on 20 to 30 acres of native grass land would carry a steer through a 10 months grazing season.

Morton Silty Clay Loams — Shallow Phase

The shallow phase of the Morton sity clay loams has fine grained, grayish-brown, silty clay mulches on the surface. The humus-bearing layers are shallow grayish-brown to dark grayish-brown granular silty clay loams with fair columnar structure. The carbonate zone below 6 to 10 inches is a compact lime-streaked silty clay loam grading into stratified grayish olive-brown silts and silty clays with depth. Fragmentary fine sandy shales outcrop and underlie occasionally the tracts at comparatively shallow depths. The deeper and darker colored phases occur at the head of coulees, on the divide northwest of Winifred, and on the tracts east of Dry Wolf Creek. The soils developed over the stratified sandy shales of the Colorado formation in T. 15 N., R. 23 and 24 E. have duller or paler colored surface soils, and fragmentary sandy shales underlie the tracts at comparatively shallow depths. This shallow phase covers (1) a portion of the divide between the Judith River and Dog Creek northwest of Winifred, (2) isolated tracts east of Dry Wolf Creek, and (3) tracts in T. 15 N., R. 23 and 24 E. It is classified as farming

grazing land and grazing land on the land classification map, and covers 32.2 square miles, most of which is tillable.

Utilization.—Stock raising and grain growing are usually combined on the shallow phase of the Morton silty clay loams. The acreage under cultivation in 1930, distributed largely over the tracts in the northwestern part of the county, amounted to approximately 50 per cent of the total area. The amount of nitrogen and phosphorus in the surface acre foot of soil compares favorably with the Morton loams, except in the eastern part of the county. The yields of spring wheat on summer fallowed land average between 7 and 10 bushels per acre on the more shallow phase, and 12 to 15 bushels or more on the deeper and darker colored phases in basins on the crest of the divide and along Dry Wolf Creek.

Vegetation.—The grass cover on the tracts consists chiefly of western wheat grass with some grama grass, and the forage on 25 to 30 acres would carry a steer through a 10 months grazing season. In the east central part of the county black sage occurs on some of the tracts and the forage on 35 acres would be required to carry a steer through a 10 months grazing season.

Morton Silty Clay Loams

The Morton silty clay loams, developed over the stratified sandy shales of the Colorado formation have much paler or grayish colored surface soils than is typical of the Morton silty clay loams. The lime streaked carbonate zones below 8 to 14 inches grade into fragmentary sandy shales with depth. These heavy loams cover isolated rolling tracts on the divide between McDonald and Fords creeks in the east central part of the county. They are classified as farming grazing land on the land classification map and cover 24.3 square miles of which 2.7 square miles are unsuitable for farming.

Utilization.—The Morton silty clay loams occur chiefly in stock raising sections and are devoted chiefly to the production of forage crops. Approximately 15 per cent of the total area was under cultivation in 1930. Chemical analysis of these soils indicates a lower productivity than for the Morton loams. The yields of spring wheat on the divide north of Novary Post Office average between 7 to 10 bushels per acre with occasional higher yields in favorable seasons.

Vegetation.—Western wheatgrass and grama grass form the chief cover, and the forage on 25 to 30 acres would carry a steer through a 10 months grazing season.

Morton Silty Clay Loams — Gravelly Phase

The gravelly phase of the Morton silty clay loams, also developed over stratified sandy shales of the Colorado formation,

differs chiefly from the silty clay loams in having fragments of sandy shales in the surface soils. The subsoils below one to 2 feet consist chiefly of disintegrated stratified sandy shales. These sandy shales outcrop about the borders of the tracts.

The gravelly phase of the Morton silty clay loams occurs on gently sloping to rolling benches south of McDonald Creek in the vicinity of Novary Post Office. It is classified as farming grazing land on the land classification map and covers 6.2 square miles of which about 30 per cent was under cultivation in 1930. The yields of spring wheat on summer fallowed land average 8 to 10 bushels per acre. The native grass lands, covered chiefly with western wheat grass, have a livestock carrying capacity of 25 to 30 acres per steer for a 10 months grazing season.

Morton Stony Loams

Morton stony loams include a group of undifferentiated stony soils having, in general, the profiles of the Morton loams and sandy loams. The soils, developed over the Kootenai sandstones in the southeastern part of the county are predominately stony sandy loams, characterized by rock outcrops and by sandstone slabs on the surface. The soils developed over the Judith River formation in T. 19 N., R. 18 E. are chiefly stony loams with sandstones outcropping on the slopes of drainage courses and forming the shell rock or fragmentary sandstones on the knolls in the broken upland sections. The stony loams in the townships to the north are characterized by sandstone outcrops on slopes of coulees and by shell rock on the tops of hills and ridges. Along Ming Coulee, sandstones outcrop above the escarpments of the stream courses and locally in the uplands. The surface soils on the tracts in the southeastern part of the county are somewhat darker colored and deeper than in the northwestern part.

The Morton stony loams occur on gently sloping to broken tracts in the northwestern and southeastern parts of the county. These stony loams, classified as non-tillable grazing land on the land classification map, cover 89.5 square miles of which 24.8 square miles are broken. The tracts are used mainly for the grazing of livestock. The bunch grass, associated with other grasses and shrubs, form the chief cover and the forage on 20 to 25 acres would carry a steer through a 10 months grazing season.

Morton Stony Loams — Timbered Phase

The rougher phases of the Morton stony loams in the southeastern part of the county and on the divides along the Judith River and Armells Creek are covered with an open stand of yellow pine. The stand of timber does not greatly influence the character of the soils, except immediately under the trees, and in the denser patches where the surface soils may be slightly bleached by leach-

ing from the shallow leaf mold. The timbered phase of the Morton stony loams, classified as non-tillable land on the land classification map, covers 80.2 square miles. The land is used for the grazing of livestock. The grass cover is similar to that found on the Morton stony loams. The forage on 35 to 50 acres, depending upon topography and stand of timber, could carry a steer through the 9 to 10 months the area is free from snow. The heaviest stands of timber are found on the divide in the vicinity of Battrick.

TETON LOAMS

The surface 2 to 3 inches of the Teton loams is a dark colored fine sandy mulch often containing a fair amount of leaf mold and plant root fiber. The humus-bearing layers are dark grayish-brown granular loams and silt loams, 5 to 8 inches thick. The sub-surface layers are brown blocky structured silt loams in the upper part and compact, structureless silty clays in the lower part. The grayish-brown silty clay carbonate zones lie 16 to 30 inches below the surface and grade into fragmentary sandstones at various depths. Sandstones outcrop and underlie locally the surface of the more rolling tracts at comparatively shallow depths. The Teton loams grade into the Adel loams on the McDonald Creek Divide east of Lewistown and on the higher slopes in the Judith Mountains. These loams, classified as farming land and as non-tillable grazing land on the land classification map, occur on gently to steeply sloping benches and on rolling to broken upland tracts on the slopes of divides and mountains in the central part of the county. The steeply sloping benchlands on the divide south of the South Fork of McDonald Creek are broken by intrenched stream courses. They cover 61.4 square miles of which 25.7 square miles are too broken for cultivation.

Utilization.—Before the railway entered, the areas covered with the Teton loams were among the best grazing lands in the county. During the development of dry-land farming in this part of the state, many of the large stock ranches located on these loams were subdivided into farming units and the tillable land placed under cultivation. A combination of stock raising and grain growing is usually practiced on these loams. The small grains are grown chiefly on continuously cropped land with an occasional year of clean summer fallow to control weeds. In 1930, approximately 75 per cent of the tillable land was under cultivation and it was devoted largely to small grains and forage crops. The surface acre foot of soil contains 4500 to 6500 pounds of nitrogen and 1500 to 2000 pounds of phosphorus. The yields of spring wheat on summer fallowed land average above 20 bushels per acre with occasional yields of 30 to 35 bushels. The growing season decreases with the elevation and occasionally small grains are damaged by

early fall frosts. Winter wheat and forage crops are grown largely on the higher tracts.

Vegetation.—The tall bunch grasses (such as *Festuca idahoensis*) predominate on the loams. The grass cover is dense and the forage on 12 to 15 acres of native grass land would carry a steer through the 7 to 8 months the area is free from snow and open for grazing.

Teton Loams — Shallow Phase

The shallow phase of the Teton loams has the same profile as the Teton loams. The tracts are underlaid at comparatively shallow depths with disintegrated sandstones. The sandstones outcrop and occur locally as slabs on the surface. This phase, mapped chiefly on the McDonald Creek Divide east of Lewistown and locally on the northern slope of the divide south of the South Fork of McDonald Creek, covers steeply sloping to gently rolling upland tracts above intrenched stream courses. The tracts, classified as non-tillable grazing land on the land classification map, cover 16.9 square miles of which about 40 per cent was under cultivation in 1930. The cropped acreage devoted chiefly to forage crops was well distributed. The land has a good cover of the tall bunch grasses and a somewhat lower livestock carrying capacity than the loams.

Teton Sandy Loams

The Teton sandy loams are characterized by sandy surface mulches. The humus-bearing layers are dark grayish-brown sandy loams and coarse sandy loams, underlaid with compact brown sandy subsurface layers. The soils usually effervesce with acid above the disintegrated sandstones which underlie the tracts at varying depths. Sandstones outcrop and sandstone slabs occur on the surface of the coarse sand loams in T. 18 N., R. 19 E.

The Teton sandy loams occur on steeply sloping tracts on the southern slopes of the Judith Mountains and on the northern slopes of the divide south of the South Fork of McDonald Creek. These sandy loams, classified as non-tillable grazing land on the land classification map, cover 7.4 square miles of which approximately 40 per cent was under cultivation in 1930. The cropped acreage, devoted chiefly to forage crops was distributed largely over the tracts south of the South Fork of McDonald Creek. Bunch grasses predominated on the sandy loams, and the livestock carrying capacity is about the same as for the shallow phase. A light stand of yellow pine occurs locally on the tracts.

Teton Sandy Loams — Red Phase

The red phase of the Teton sandy loams, developed over the red sandstones of the Kootenai formation, has a similar soil development to the Teton sandy loams. The surface soils are dark reddish-brown sandy loams and coarse sandy loams with compact

reddish-brown structureless sandy subsurface layers. The slightly heavier textured, reddish-gray carbonate zone below 16 to 30 inches grades into disintegrated red sandstones at varying depths. The deeper sandy loams are found on the tracts in the vicinity of Battick. Coarse sandy loams predominate on the tracts in T. 13 N., R. 22 E.

The red phase of the Teton sandy loams occurs on isolated gently rolling tracts in the southeastern part of the county. These loams, classified as grazing forage land on the land classification map, cover 15.0 square miles of which one square mile is too broken for farming. The cropped acreage, amounting to approximately 50 per cent of the area, was confined largely to the production of spring wheat and to forage crops. The yields of spring wheat on land summer fallowed occasionally to control weeds are somewhat higher than on the Morton loams in the area. The bunch grasses predominate and the forage on 20 to 25 acres of native grass land would carry a steer through a 9 to 10 months grazing season.

Teton Stony Loams

The Teton stony loams include a group of undifferentiated shallow stony sandy soils, having the profile of the Teton sandy loams. These stony loams, characterized by sandstone outcrops and slabs of sandstone on the surface, occur chiefly on the divide east of Lewistown and on the divide south of the South Fork of McDonald Creek. The tracts broken with intrenched stream courses are classified as non-tillable grazing land on the land classification map and cover 92.5 square miles of which 6.1 square miles have a smooth, gently sloping topography. The stony loams, utilized chiefly for the grazing of livestock have a good cover of the tall bunch grasses and the forage on 15 to 20 acres would carry a steer through a 7 to 8 months grazing season.

Teton Stony Loams — Timbered Phase

The more broken phases of the Teton stony loams in the central part of the county support a fair stand of yellow pine. The shallow soils having a bleached yellowish to yellowish-brown color show the influence of a timber cover. This phase, classified as non-tillable grazing land on the land classification map, covers 123.6 square miles. Isolated tracts devoted to small grains and forage crops are distributed through the timbered area. The livestock carrying capacity of the timbered phase is comparatively low and in some sections the forage is more palatable to sheep than to cattle.

ADEL LOAMS

The surface few inches of the Adel loams form a dark colored fibrous mat of organic matter. The humus-bearing layers are vary dark grayish-brown almost black granular silt loams, 6 to 9 inches

thick. The subsurface layers often having a reddish-brown color are granular silty clay loams grading into structureless, noncalcareous silty clays and sandy silty clays with depth. The tracts are underlaid at various depths with fine-grained crystalline sandstones, which locally outcrop and occur as slabs on the surface. The Adel loams in Fergus County include small tracts of Zortman loams developed over limestone. These loams, classified as farming grazing land on the land classification map, occur on high gently sloping benchlands and smooth, steeply sloping tracts in the higher foothills of the Big Snowy and Judith mountain. They cover 37.5 square miles of which 7.7 square miles are sharply rolling.

Utilization.—The Adel loams lie above 5000 feet in elevation and have a short cool growing season which limits the type of farming and the varieties of crops grown. In 1930, approximately 40 per cent of the area was under cultivation and the cropped lands were devoted largely to forage crops such as timothy, clover, and the small grains grown for hay. The land under cultivation was well distributed. The surface acre foot of soil contains 6000 to 10,000 pounds of nitrogen and 2400 to 3000 pounds of phosphorus. The yields of forage crops in normal seasons are good.

Vegetation.—The native grass lands have a dense cover of the upland sedges, red top, mountain timothy, and other grasses and shrubs, and have a high livestock carrying capacity during the 6 to 7 months the tracts are free from snow. The vegetation is somewhat more palatable to sheep than to cattle. The smoother tracts are often used for wild hay lands.

Adel Stony Loams

The Adel stony loams, with a profile similar to the Adel loams, are characterized by sandstone outcrops and by slabs of sandstone on the surface. These stony loams also include small tracts of the Zortman loams. They occur on benchlands and on rolling ridges in the foothills of the Big Snowy Mountains and also cover a pass in the eastern part of the Judith Mountains. The tracts classified as non-tillable grazing land on the land classification map cover 23.4 square miles of which 12.3 square miles have a smooth stony relief. The stony loams are used chiefly for the grazing of livestock. The smoother and less stony tracts are occasionally devoted to forage crops or are used for wild hay lands. The tracts have a dense cover of the sedges, grasses, and shrubs found on the loams, and have a high livestock carrying capacity during the 6 to 7 months the area is free from snow.

BLAINE LOAMS

The Blaine loams have dark colored sandy surface mulches, containing a fair amount of fibrous organic matter. The humus-bearing layers are dark grayish-brown to very dark grayish-brown

granular loams and stony loams 5 to 7 inches thick. The subsurface layers are compact silt loams to silty clay stony loams, occasionally having a reddish-brown color. The stony grayish-brown silty clay carbonate zone below 10 to 24 inches grades into igneous rock and rock fragments. The amount of rock on the surface and in the soils varies with the different tracts. These loams cover the less stony and broken foothill sections of the Moccasin and Judith mountains. They are classified as farming land and as grazing land on the land classification map and cover 83.5 square miles of which 21.3 square miles are sharply rolling.

Utilization.—A combination of stock raising and grain growing is practiced on many of the farms located on the tracts. In 1930, approximately 60 per cent of the land suitable for farming was under cultivation and devoted mainly to small grains and forage crops. The surface acre foot of soil on the tracts under cultivation contains 4500 to 5500 pounds of nitrogen and 1800 to 2100 pounds of phosphorus. The nitrogen content of some of the higher tracts runs as high as 7000 to 8000 pounds. The yields of spring wheat on land occasionally summer fallowed are between 18 and 22 bushels per acre.

Vegetation.—The tall bunch grasses predominate, and the tracts have a high livestock carrying capacity during the 7 to 8 months the area is free from snow.

Blaine Stony Loams

The Blaine stony loams have a soil development similar to the Blaine loams. Igneous rock occurs on the surface of the tracts and the amount increases with the soil depth. The stony tracts east of Black Butte, with carbonate zones 10 to 12 inches below the surface, represent a dark grayish-brown phase of these stony loams. The Blaine stony loams were mapped in the foothills and on the stony benches extending out from the Moccasin and Judith mountains. The land, classified as grazing land and as non-tillable grazing land on the land classification map, covers 79.0 square miles of which 16.6 square miles have a smooth stony topography. The land is not under cultivation except for isolated tracts devoted mainly to forage crops on the more gentle and less stony slopes of the hills and ridges. The grass cover and livestock carrying capacity of the stony loams are about the same as for the loams. A light stand of yellow pine occurs on a few of the higher ridges.

ZORTMAN STONY LOAMS

The Zortman stony loams have dark colored fibrous organic surface mulches. The humus-bearing layers are black friable granular loams and silt loams 7 to 9 inches thick. The lower soil depths are dark brown to reddish-brown granular silty-clay loams grading into structureless yellowish-brown silty clays, effervescing with acid

immediately above the fragmentary limestone. Limestone, underlying the tracts at varying depths, outcrops and occurs as boulders on the surface.

The Zortman stony loams occur on high ridges in the foothills of the Big Snowy Mountains in the southeastern part of the county. These stony loams classified as non-tillable grazing land on the land classification map cover 2.5 square miles. The tracts are too stony and lie at too high an elevation for farming and are used as summer grazing lands. The type of vegetation on the tracts and the livestock carrying capacity are about the same as for the Adel loams during the 6 to 7 months the area is free from snow.

MOCCASIN GRAVELLY LOAMS

The Moccasin gravelly loams on the tablelands southwest of Lewistown have dark colored fine-grained silty clay mulches on the surface. The upper 2 to 4 inches of the humus-bearing layers are a dark grayish-brown to very dark grayish-brown granular silt loam to silty clay loam, grading into a columnar structured gravelly silt loam to gravelly silty clay loam. The grayish-brown semi-consolidated gravelly carbonate zone lies below 8 to 12 inches and at 36 to 42 inches grades into unconsolidated yellowish-brown gravelly silt and silty clay material, which is locally stratified. The amount and depth of the limestone gravels vary on the different tracts. The deeper and less gravelly soils are found usually in basins at the head of drainage courses.

The lower portion of many of the gravel-capped benches in Judith Basin County extends across the county line into Fergus County. The soils on these benches were undifferentiated in Fergus County and were grouped with the Moccasin gravelly loams. The humus-bearing layers on these benches are dark grayish-brown to rich brown, columnar structured gravelly silt loams and gravelly silty clay loams with gray to grayish-brown semi-consolidated gravelly silty clay carbonate zones below 6 to 10 inches. The unconsolidated yellowish-brown gravelly silt to gravelly silty clay material lies below 30 inches or more. The soils on the rolling bench rising above the gravel-capped tablelands west of Beaver Creek have some rock on the surface and have less gravelly and consolidated subsoils than on the tablelands. Limestone and crystalline sedimentary rock with some igneous rock make up most of the rock and gravel found in the soils on this tract.

The Moccasin gravelly loams occur (1) on the tableland or plateau, dissected with stream valleys east of the Judith River and south of Warm Springs Creek, (2) on smooth gently sloping tongues of the benchlands in the west central part of the county, and (3) on a rolling bench rising above the tablelands west of Beaver Creek. These gravelly loams, classified as farming land on the land classification map, cover a total area of 86.5 square miles of

which 51.1 square miles lie east of the Judith River, 27.2 square miles on the tongues of the benches in the west central part, and 8.2 square miles on a high rolling bench west of Beaver Creek.

Utilization.—The Moccasin gravelly loams were placed under cultivation soon after the railway entered the county. Exclusive grain growing has been generally followed on the large grain farms, but with serious soil drifting on the lower benches some change in the farming practices, if not in the type of farming, is necessary to hold the soil in place. In 1930 nearly all the land east of the Judith River was under cultivation, about 80 per cent of the area in the west central part, and less than 15 per cent on the high bench west of Beaver Creek. Winter wheat was grown almost exclusively on these gravelly loams up to about 1915, when several consecutive years of severe winter killing caused a change to be made to spring wheat. Continuous cropping to wheat was followed until the land became infested with weeds, when a year of clean summer fallow was introduced to control weeds. The cropping system practiced at the present time is to grow spring wheat on summer fallowed land followed by winter wheat often seeded in the spring wheat stubble. Summer fallowing of land does not greatly increase crop yields, because of the low water holding capacity of the gravelly subsoils and also because the normal rainfall during the growing season is between 7 and 9 inches. The yields of spring wheat on summer fallowed land average between 15 and 18 bushels per acre on the deeper and less gravelly soils, with occasional higher yields of 30 bushels or more in favorable seasons. The surface acre foot of soil contains 5000 to 6000 pounds of nitrogen and 1500 to 2400 pounds of phosphorus.

Vegetation.—Western wheat grass associated with grama on the lower branches and with the bunch grasses on the higher, form the chief cover, and the forage on 12 to 18 acres of native grass land would carry a steer through an 8 to 9 months grazing season on the different benches.

Moccasin Gravelly Loams — Shallow Phase

The shallow phase of the Moccasin gravelly loams differs chiefly from the gravelly loams in having somewhat more shallow and lighter colored surface soils. The soils on the tracts along Wolf Creek are silt and silty clay gravelly loams; on the divide between Coffee and Wolf Creeks they are sandy gravelly loams grading locally into coarse sandy loams, and on the bench south of Grass Range are gravelly loams. Wind-blown material from the breaks or escarpments of the benches locally modify the surface soils on the tracts in the west central part of the county.

The shallow phase of the Moccasin gravelly loams occurs on gently sloping tongues of benches in the west central part of the county and on other limestone gravel-capped benches at the lower

elevations. This phase classified as farming land on the land classification map covers 10.3 square miles. All the tillable land on the benches was under cultivation in 1930 and devoted chiefly to the production of spring wheat. The amount of nitrogen in the surface acre foot of soil averages lower than in the gravelly loams. The yields of spring wheat on land occasionally summer fallowed are between 12 and 15 bushels per acre. Western wheat grass and grama grass predominate on the tracts and a few more acres would be required to carry a steer through a 9 to 10 months grazing season than would be required on the gravelly loams.

Moccasin Gravelly Silty Clay Loams

The Moccasin gravelly silty clay loams have somewhat deeper and less gravelly surface soils and less gravel in the subsoils than the gravelly loams. These gravelly silty clay loams, classified as farming land on the land classification map, cover 17.2 square miles on the lower part of the Coyote Bench between Coyote and Running Wolf creeks in the west central part of the county. The bench is all under cultivation and is devoted chiefly to the production of spring and winter wheat. The surface acre foot of soil contains 5500 to 6500 pounds of nitrogen and 2000 to 2400 pounds of phosphorus. The surface and subsoils have a greater water holding capacity than the gravelly loams, and the yields of spring wheat on summer fallowed land average between 15 and 20 bushels per acre. Western wheat grass forms the chief cover, and the forage on 15 acres of native grass land would carry a steer through a 9 to 10 months grazing season.

Moccasin Gravelly Sandy Loams

The surface few inches of the Moccasin gravelly sandy loams is a dark colored sandy mulch. The humus-bearing layers are friable dark to very dark grayish-brown sandy loams and gravelly sandy loams 5 to 7 inches thick, overlying a lighter colored columnar structured gravelly subsurface layer. The grayish-brown heavier textured carbonate zone below 12 to 24 inches grades into yellowish-brown gravelly sandy material at 42 inches or more. The amount of limestone gravel in the surface soil averages less than in the gravelly loams and the carbonate zone is less consolidated.

The Moccasin gravelly sandy loams cover the higher portion of the western slopes of the tableland west of Beaver Creek in the southwestern part of the county. These sandy loams, classified as farming land on the land classification map, cover 16.4 square miles nearly all of which is devoted to the production of spring and winter wheat. The surface acre foot of soil contains about the same amount of nitrogen and a slightly smaller

amount of phosphorus than the gravelly loams. The yields of spring wheat on land occasionally summer fallowed is between 15 and 20 bushels per acre. Soil drifting is becoming increasingly more difficult to control in the older cropped sections and the yields of spring wheat have been declining. The tracts had a good grass cover and a high livestock carrying capacity before they were placed under cultivation.

Moccasin Gravelly Sandy Loams — Shallow Phase

The shallow phase of the Moccasin gravelly sandy loams, lying at a lower elevation than the gravelly sandy loams, ranges from dark grayish-brown gravelly sandy loams with carbonte zones 7 to 10 inches below the surface above Ross Fork Creek to very dark grayish-brown gravelly fine sandy loams with carbonate zones below 12 to 15 inches in the vicinity of Moore. The amount of limestone gravel in the surface and subsoil of the shallow phase is somewhat greater than in the gravelly sandy loams.

The shallow phase of the Moccasin sandy loams, classified as farming land on the land classification map, covers 13.6 square miles on the western slopes of the tableland above Ross Fork Creek in the southeastern part of the county. In 1930, approximately 80 per cent of the area was under cultivation and the cropped acreage was devoted largely to the production of spring and winter wheat. The fine sandy loams in the vicinity of Moore contain about the same amount of phosphorus and nitrogen as the gravelly sandy loams, but the nitrogen content decreases toward Ross Fork Creek. The yields of spring wheat on land occasionally summer fallowed are less than 10 bushels per acre on the lighter soils above Ross Fork Creek and 12 to 15 bushels per acre on the fine sandy loams in the vicinity of Moore. Soil drifting has become increasingly more difficult to control, and above Ross Fork Creek it has caused some land abandonment. The grass cover and livestock carrying capacity was somewhat less on the shallow phase than on the gravelly sandy loams before the land was placed under cultivation.

Moccasin Stony Loams

The Moccasin stony loams covering several very gravelly tracts with some limestone rock on the surface along drainage courses in the southwestern part of the county have a soil development similar to the Moccasin gravelly loams. The tracts classified as farming land on the land classification map cover 6.8 square miles. The land is under cultivation and devoted chiefly to the production of forage crops and spring wheat. The yields of spring wheat average comparatively low. Soil drifting has ex-

posed much gravel and rock on the surface. The grass lands had a fair livestock carrying capacity before they were placed under cultivation.

Moccasin Loams —Dark Phase

The dark phase of the Moccasin loams, bordering the foothills of the Big Snowy Mountains have dark colored loamy organic surface mulches. The humus-bearing layers are very dark grayish-brown friable loams and granular silt loams, 6 to 8 inches thick. The subsurface layers are compact silt loams and silty clay loams with fair columnar structure. The grayish-brown, heavy textured carbonate zone lies below 12 to 17 inches and grades into yellowish-brown gravelly and stony silty clay material with depth. Some limestone gravel is found in the surface soils, and limestone rock occurs locally on the surface below the foothills. Soils developed over tufa or hot spring deposits in T. 15 N., R. 18 E. are included in this phase. Calcareous hot spring deposits occur in the foothills of the Big Snowy Mountains and on the McDonald Creek Divide, but most of the tracts are too small to be shown on the soil map.

The dark phase of the Moccasin loams occurs on the higher part of the tableland below the foothills of the Big Snowy Mountains and on high benches in the foothills of these mountains. The plateaus, dissected with mountain stream courses, have smooth gentle slopes. The land is classified as farming land on the land classification map and covers 46.1 square miles, nearly all of which is under cultivation. These soils, containing 6000 to 7000 pounds of nitrogen and 1800 to 2000 pounds of phosphorus in the surface acre foot are the most productive winter and spring wheat soils in the county. The yields of spring wheat, grown occasionally on summer fallowed land to control weeds, average above 20 bushels per acre. Before the land was broken out, it had a dense cover of the tall bunch grasses and a high livestock carrying capacity during the 7 to 8 months the tracts were open for grazing.

Moccasin Gravelly Loams — Dark Phase

The dark phase of the Moccasin gravelly loams, having a similar soil development as the dark phase of the Moccasin loams, occurs on high benches and ridges capped with outwash from the mountains in the southwestern part of the county. This phase is characterized by dark colored granular gravelly surface soils and by stony gravelly subsoils, grading into limestone rock and gravel imbedded in yellowish-brown silty clay material. The dark phase, classified as farming land on the land classification map, covers 10.2 square miles. The cropped acreage (approximately 50 per cent of the area) was devoted largely to forage crops and winter and

spring wheat. The average yields of spring wheat on the less gravelly and stony soils are between 15 and 18 bushels per acre. The native grass lands have a good cover of the tall grasses and a high livestock carrying capacity during the 7 to 8 months the tracts are free from snow.

DANVERS SILTY CLAY LOAMS

The surface 2 to 3 inches of the Danvers silty clay loams on the Coffee Creek, Everson and Bear Springs benches are a dark grayish-colored laminated fine-grained silty clay mulch. The humus-bearing layers, having a fair columnar structure and breaking into fine angular fragments, are dark grayish-brown to dark brown silty clay loams 5 to 7 inches thick. The subsurface layers are compact brown fine cloddy silty clays and clays without definite structure. The grayish-brown heavy textured carbonate zone below 6 to 18 inches is streaked and blotched with lime and at 2 to 4 feet or more grades into yellowish-brown limestone gravelly silty clay material, such as is found on the gravel-capped tablelands. The heavy material overlying the limestone gravels is derived largely from wind-borne material from the shaly escarpments and stream breaks bordering the benches. The wind-borne material rises locally as low mounds along the western borders of the benches, and it becomes more shallow in the eastern part of the tracts.

The tracts west of the Judith River in the vicinity of Danvers are underlaid at 2 to 3 feet or more with comparatively loose stratified gravels. The soils on the tract east of the river are deep, refractory silty clays and clay loams underlaid at considerably greater depths with limestone and other gravels.

The Danvers silty clay loams occur on the Coffee Creek, Everson, Bear Springs, and other benches (such as the Danvers) along the Judith River in the west central part of the county. These benches with indented borders have a smooth gently sloping topography locally broken with deeply intrenched stream courses. The tracts along the Judith River are quite level and are locally in need of drainage below irrigation canals. These heavy loams classified as farming land on the land classification map, cover 83.2 square miles.

Utilization.—The Danvers silty clay loams are among the most productive winter wheat soils in the area and nearly all the tillable land is under cultivation. The surface acre foot of soil contains 4500 to 5500 pounds of nitrogen and 1800 to 2400 pounds of phosphorus. The yields of spring and winter wheat on land summer fallowed about every third year to control weeds average 20 bushels or more per acre, with occasional yields of 35 to 40 bushels in favorable seasons. Summer fallowed land, granu-

lated and mellowed by frost, is likely to drift in dry seasons.

Vegetation.—Western wheat grass forms the chief cover, and the forage on 15 acres of native grass land would carry a steer through a 9 to 10 months grazing season.

Danvers Loams

The Danvers loams are characterized by shallow surface mulches, by dark grayish-brown columnar structured humus-bearing layers, and by compact subsurface layers. The carbonate zone lies below 20 to 25 inches and grades into the limestone gravelly silty clay material found under the silty clay loams at varying depths. The surface soils are chiefly loams and silt loams, depending upon the nature of the rock outcrops in the breaks bordering the benches.

The Danvers loams occur largely in the northern part of the Coffee Creek and Everson benches. These loams, classified as farming land on the land classification map, cover 29.0 square miles, nearly all of which is devoted to spring and winter wheat. The surface acre foot of soil contains approximately the same amount of nitrogen and phosphorus as is found in the silty clay loams. The productivity and livestock carrying capacity of these loams do not greatly differ from that of the silty clay loams.

Danvers — Sandy Loams

The northern extremity of the Coffee Creek Bench lies above sandstone breaks, and the surface soils are shallow dark grayish-brown sandy loams, underlaid with limestone gravels at varying depths. Low sandy hummocks rise along the western border of the tract. These sandy loams, classified as farming land on the land classification map, cover 3.8 square miles, nearly all of which is under cultivation. The soils have a low productivity and the yields of spring wheat average less than 10 bushels per acre. The original grass cover consisted chiefly of grama grass and western wheat grass, and the tract had a fair livestock carrying capacity.

DENTON GRAVELLY SILTY CLAY LOAMS

The soils of the Denton series, containing some limestone gravel and showing a good soil development, have developed in rolling areas below the gravel-capped tablelands and are underlaid with residual material at varying depths. The Denton gravelly silty clay loams have the characteristic regional mulch on the surface. The humus-bearing layers, containing more or less limestone gravel, are dark grayish-brown, columnar structured, silty clay loams, breaking readily into angular fine grains. The carbonate zone also contains some limestone gravel and is

a lime streaked and blotched olive-brown silty clay loam below 10 to 16 inches and grades into grayish olive-brown gravelly silty clays with depth. The tract north of Wolf Creek has a more pronounced gravelly substratum, and locally the soils grade into the Danvers silty clay loams.

The Denton gravelly silty clay loams occur on gently sloping tracts above Wolf Creek in the west central part of the county. These heavy loams, classified as farming land on the land classification map, cover 18.5 square miles all of which is under cultivation and devoted to the production of spring and winter wheat. The surface acre foot of soil contains 5000 pounds of nitrogen and 2000 pounds of phosphorus. The yields of spring wheat on summer fallowed land average about 20 bushels per acre. The native grasslands have a good cover of western wheat grass and a high livestock carrying capacity.

Denton Silty Clay Loams

The surface soils of the Denton silty clay loams are very dark grayish-brown granular silty clay loams, underlaid with a compact silty clay subsurface layer. The lime streaked and blotched carbonate zone below 24 to 30 inches grades into grayish olive-brown silty clays containing a small amount of limestone gravel.

The Denton silty clay loams occupy a basin northeast of Denton. These heavy loams, classified as farming land on the land classification map, cover 8.0 square miles, all of which is devoted to the production of spring and winter wheat. The amount of nitrogen and phosphorus in the surface acre foot of soil compares favorably with that found in the gravelly silt loams. The yields of spring wheat on summer fallowed land are among the highest obtained in the county. The land had a good grass cover and a high livestock carrying capacity before it was placed under cultivation.

Denton Loams

The surface soils of the Denton loams are friable, dark grayish-brown loams and silt loams, containing a small amount of limestone gravel. The subsurface layers are quite compact and grade into lime-streaked gravelly silt to silty clay carbonate zones at 16 inches. Residual material derived from sandstone underlies the tracts at varying depths. Sandstones outcrop on the more eroded ridges and the wash from them has modified locally the character of the soils. The soils in the southeastern part of the tract are sandy loams containing some gravel.

The Denton loams covering rolling areas along Wolf Creek northwest of Denton are classified as farming land on the land

classification map. These loams cover 7.5 square miles of which 65 per cent was under cultivation in 1930 and devoted chiefly to the production of spring and winter wheat. The soils average lower in nitrogen and phosphorus than the gravelly silt loams and the yields of spring wheat on summer fallowed land average between 12 and 15 bushels per acre. The land has a good stand of western wheat grass and grama grass and the forage on 20 acres of native grass land would carry a steer through a 9 to 10 months grazing season.

LLOYD GRAVELLY LOAMS

The Lloyd gravelly loams, developed on benches capped with outwash from the mountains have dark colored fine-grained surface mulches often containing a fair amount of fibrous organic matter. The humus-bearing layers are dark to very dark grayish-brown friable gravelly loams to gravelly silt loams 5 to 7 inches thick. The subsurface layers are compact gravelly silt loams and gravelly silty clay loams, occasionally having a reddish-brown color. The heavy textured grayish-brown gravelly carbonate zone below 10 to 15 inches grades into stone and gravel imbedded in silty clay material and often having a rusty brown color. Igneous rock occurs on the surface and in the soil, and on some of the higher tracts it is quite abundant. The surface soils on the more eroded and dissected benches often are very shallow and gravelly.

The Lloyd gravelly loams occur on dissected benches, capped with outwash from the Judith and Moccasin mountains in the central part of the county. The larger tracts are found on the divides between Armells and Dog creeks and between Dog Creek and the Judith River. These gravelly loams, classified as farming grazing land and grazing forage land on the land classification map, cover 19.7 square miles of which 4.5 square miles are in broken gravel-capped hills and ridges. In 1930, approximately 65 per cent was under cultivation and devoted chiefly to the production of spring wheat. The surface acre foot of soil contains 4500 to 6000 pounds of nitrogen and 2500 to 3500 pounds of phosphorus. The yields of spring wheat on the less eroded benches average between 15 and 20 bushels per acre on summer fallowed land. The land has a good cover of the bunch grasses and a high livestock carrying capacity during the 9 months the tracts are free from snow.

Lloyd Stony Loams

The Lloyd stony loams occupying high benches on the eastern slopes of the Judith Mountains have somewhat darker colored surface soils and deeper carbonate zones than the gravelly loams. The soils are very stony and the lower depths consist largely of unconsolidated igneous rock and gravel.

The soils developed on several outwash tracts below the Judith Mountains along Little Bear and Box Elder creeks are characterized by very dark colored fibrous organic surface mulches, by almost black granular stony humus-bearing layers, and by unconsolidated stony subsoils.

The Lloyd stony loams, classified as grazing land and as non-tillable grazing land on the land classification map, cover 21.7 square miles. The tracts are too stony for cultivation and are used chiefly for the grazing of livestock. Flood waters are diverted onto the tract along Little Bear Creek, and the irrigated land is devoted largely to the production of wild hay. The land has a dense cover of the tall bunch grasses and a high livestock carrying capacity during the 7 to 8 months the area is free from snow.

Lloyd Gravelly Loams — Dark Brown Phase

The dark brown phase of the Lloyd gravelly loams is characterized by grayish-brown fine-grained silty surface mulches, by dark grayish-brown columnar structured gravelly to gravelly silty clay humus-bearing layers, and by compact subsurface layers, often approaching the character of a hard pan on some of the lower benches. The gravelly grayish-brown carbonate zone, streaked and blotched with lime and locally impregnated with alkali, is very compact below 7 to 15 inches and grades into grayish olive-brown gravelly silts and silty clays overlying dark olive-brown residual material derived from shales at various depths.

The surface soils on the flat-topped ridge southeast of Winifred are shallow friable dark grayish-brown gravelly loams with deep gravelly silt to silty clay subsoils. The soils on the bench north of Roy are gravelly loams with scabby surfaces in the eastern part of the bench. The surface soils on the benches south of Gilt Edge along Fords Creek are very shallow gravelly loams with loose gravelly subsoils, and on the Minnesota Bench in the north-eastern part of T. 16 N., R. 23 E. are gravelly loams and silty clay loams with compact subsurface layers.

The dark brown phase of the Lloyd gravelly loams includes a group of undifferentiated gravelly stony soils occurring on gently sloping benches at the lower elevations in the north central and east central parts of the county. These benches are capped with outwash from the Judith Mountains and often are underlaid at comparatively shallow depths with heavy residual material derived from dark colored shales. The soils about the borders of the benches are more or less scabby and grade locally into the Gilt Edge gravelly loams. This phase, classified as farming grazing land, grazing land, and non-tillable grazing land on the land classification map, covers 82.3 square miles.

Utilization.—The less stony, gravelly and scabby phases of

the dark brown phase of the Lloyd gravelly loams were placed under cultivation at the time of settlement of the dry land areas, but most of the cropped acreage was abandoned during the drought of 1918 and 1921. A small acreage was under cultivation in 1930 on the bench southeast of Winifred, in the western part of the bench north of Roy, and locally on the benches east of Gilt Edge. The cropped lands on the Minnesota Bench have not been abandoned and are well under cultivation. Spring wheat is the chief cash crop, with other small grains grown chiefly for forage and hay. The more gravelly and scabby benches are used largely by local stockmen for the grazing of cattle and sheep. The surface acre foot of soil contains 2000 to 3000 pounds of nitrogen and 1500 to 1800 pounds of phosphorus. The soils on most of the benches have a comparatively low productivity and the average yield of spring wheat on summer fallowed land is less than 10 bushels per acre on the more productive benches.

Vegetation.—Western wheatgrass and grama grass with some black sage on the more scabby phases predominate, and the forage on 25 to 30 acres of native grass land would support a steer through a 10 months grazing season on the less scabby benches.

Lloyd Gravelly Silty Clay Loams — Dark Brown Phase

The dark brown phase of the Lloyd gravelly silty clay loams, covering a rolling area east of Roy along Box Elder Creek, differs from the gravelly loams in having somewhat more friable surface soils, less compact subsurface layers, and somewhat more shallow carbonate zones. The lower depths consist largely of heavy residual material derived from dark colored shales. This phase classified as grazing forage land on the land classification map covers 22.5 square miles of which 2.9 square miles are sharply rolling. In 1930, approximately 40 per cent of the tillable area was under cultivation and devoted chiefly to the production of spring wheat. The surface acre foot of soil contains 3000 to 4000 pounds of nitrogen and 1500 to 1800 pounds of phosphorus. The yields of spring wheat on summer fallowed land have averaged between 10 and 12 bushels per acre with maximum yields of 25 to 30 bushels in favorable seasons. The land has a fair cover of western wheatgrass and the forage on 25 to 30 acres of native grass land would carry a steer through a 10 months grazing season.

GILT EDGE GRAVELLY LOAMS

The Gilt Edge gravelly loams include a group of undifferentiated soils occurring chiefly on secondary benches capped with outwash from the Judith Mountains in the east central part of the county. The surface of the benches is characterized by

numerous scab or bare spots depressed several inches below the surface. The soil profile of the grassed-over portion of the benches is similar to the dark brown phase of the Lloyd gravelly silty clay loams except for deeper surface mulches, better developed clay pans or hardpans, and more shallow depths of the underlying residual material derived from dark colored shales. The bare spots have a profile similar to those found on the Phillips clay loams.

The Gilt Edge gravelly loams, classified as grazing land and non-tillable grazing land on the land classification map, cover 12.0 square miles. The tracts are not under cultivation and are used for the grazing of livestock. Black sage associated with western wheatgrass forms the chief cover, and the forage on 35 to 45 acres would be required to support a steer through a 10 months grazing season.

TYLER GRAVELLY LOAMS

The Tyler gravelly loams include a group of grayish-brown to dark grayish-brown soils occurring on limestone gravel-capped benches at the lower elevations in the area. These gravelly-loams on the bench south of Flatwillow Creek have grayish-brown fine-grained silty mulches on the surface. The humus-bearing layers are grayish-brown to brown, columnar structured gravelly silt loams and silty clay loams. The very gravelly carbonate zone below 7 to 10 inches is semi-cemented and grades into yellowish-brown gravelly silty clay material with depth. Rather dark colored silty clay loams with fairly well developed clay pans and with lime-blotched carbonate zones containing a fair amount of limestone gravel predominate on the bench north of Flatwillow Creek. The surface of this tract is locally scabby. The soils on the dissected benches south of the Big Snowy Mountains have somewhat darker colored surface soils and deeper carbonate zones on the higher parts of the benches.

Several isolated benches, capped with red quartzite gravel, rise above the breaks of the Missouri and Judith rivers in the northwestern part of the county. The shallow soils developed on these eroded benches are grouped in the Tyler series. The surface soils are characterized by sandy surface mulches and by reddish-brown gravelly loamy humus-bearing layers. The rusty tinted gray carbonate zone lies below 6 to 8 inches and grades into stratified gravels and sands overlying sandstone at various depths.

The Tyler gravelly loams occur on smooth benches in the extreme northwestern, southwestern and southeastern parts of the county. These gravelly loams are classified as grazing land and non-tillable grazing land on the land classification map and cover 14.7 square miles.

Utilization.—The bench south of Flatwillow Creek was placed

under cultivation in about 1913, but during the dry years of 1918-1921 most of the cropped lands were abandoned. In 1930, only a few farms were located on the benches south of Flatwillow Creek and on the benches south of the Big Snowy Mountains in Fergus County. The surface acre foot of soil of these benches contains 2500 to 3500 pounds of nitrogen and 1800 to 2200 pounds of phosphorus. The yields of spring wheat on summer fallowed land average less than 10 bushels per acre. A large portion of the surface soils have been removed from the abandoned farm lands by soil drifting.

Vegetation.—The benches about the mountains have a fair cover of the bunch grasses, and the forage on 25 to 30 acres would carry a steer through a 10 months grazing season. Grama grass and nigger wool form the chief cover on the quartzite gravel-capped benches in the northwestern part of the county, and the forage on 30 acres would carry a steer through the same grazing period.

Tyler Gravelly Loams — Cemented Phase

The cement phase of the Tyler gravelly loams has somewhat more shallow surface soils than the loams and is underlaid with more firmly consolidated gravelly carbonate zones. The lower depths consist chiefly of loose limestone gravel and rock. Fragments and blocks of cemented gravels occur locally on the surface and in the soil.

The cemented phase of the Tyler gravelly loams covers the western part of the bench south of Flatwillow Creek. This phase, classified as grazing forage land on the land classification map, covers 4.7 square miles. Most of the area was broken out between 1913 and 1915 and abandoned largely after 1919. Soil drifting has exposed the limestone gravel and rock over a large portion of the tract. The abandoned farm lands have been slow to grass over and have a low livestock carrying capacity.

Tyler Stony Loams

The Tyler stony loams include a group of stony soils occurring on benches along Flatwillow Creek below the Little Snowy Mountains and on outwash fans on the southern slopes of the Big Snowy Mountains. The surface soils on the benches along Flatwillow Creek are shallow grayish-brown to brown gravelly stony loams, underlaid with loose limestone gravel and rock. The soils on the outwash fans south of the Big Snowy Mountains have darker colored surface soils with carbonate zones 8 to 12 inches below the surface. The lower depths consist largely of loose limestone gravel and rock.

The Tyler stony loams, classified as non-tillable grazing land on the land classification map, cover 24.4 square miles of which

11.4 square miles is lightly timbered and so shown on the soil map. The non-timbered tracts south of the Big Snowy Mountains have a good cover of the tall bunch grasses and shrubs, and the forage on 20 acres would carry a steer through a 10 months grazing season. The stony benches along Flatwillow Creek do not have as dense a grass cover and a few more acres would be required to support a steer through the same length grazing period. The timbered phase has a low livestock carrying capacity.

LOWRY LOAMS

The Lowry series includes a group of undifferentiated soils covering the slopes of gravel-capped benches at the lower elevations in the county. The soils of this series, developed chiefly over wash from the benches are quite variable in texture and depth. In general the soil development is similar to that found on the benches.

The gravelly loams on the eastern slopes of the divide west of Dog Creek are underlaid at various depths with sandstones. These gravelly loams, covering a rather rolling area, have about the same soil development and productiveness as the Morton loams found in the vicinity. The heavy soils on the slopes of the benches, underlaid with shale in the eastern part of the county, are quite shallow and gravelly and are used chiefly for the grazing of livestock. The silty clay loams, containing a small amount of limestone gravel on the eastern slopes of the benches in the west central part of the county, grade into the Danvers silty clay loams. Most of the land has a smooth gentle slope and is fully as productive as the Danvers silty clay loams. Deep gravelly loams, locally in need of drainage, cover the eastern slopes of the gravel-capped benches west of the Judith River in the west central part of the county. These gravelly loams are locally dissected with coulees.

The Lowry loams, classified as farming land, farming grazing land, and non-tillable grazing land on the land classification map, cover 66.5 square miles of which 27.4 square miles are too steep and broken for cultivation. The tillable land in the western and northern parts of the area is well under cultivation and the more gentle slopes often have a high productivity. Most of the non-tillable land has a fair grass cover and a good livestock carrying capacity.

Lowry Gravelly Loams — Dark Phase

The dark phase of the Lowry gravelly loams includes another group of undifferentiated soils covering the slopes of gravel-capped benches at the higher elevations in the county. This phase also includes upland tracts about the Moccasin and Judith moun-

tains having sufficient gravel on the surface to modify the character of the surface soils.

The loams and gravelly loams underlaid with sandstone at various depths, west of Dog Creek have about the same soil development and fertility as the Teton loams found in the vicinity of the tracts. The dark colored gravelly loams covering the gravel-capped hills and ridges and broken slopes of the benches along Armells Creek, are utilized for grazing. Gravelly loams and stony loams underlaid at various depths with sandstone and shale occur on isolated upland tracts and on the slopes of stony benches about the Moccasin and Judith mountains. The less stony and broken phases of these dark colored soils are under cultivation. Gravelly loams cover the slopes of benches in the south central part of the county. The slopes of these benches are too steep and gravelly for farming and are used chiefly for grazing of livestock. Along Warm Springs Creek the more gentle slopes of the benches are under cultivation.

The dark phase of the Lowry gravelly loams, classified chiefly as farming land and non-tillable grazing land on the land classification map, covers 95.6 square miles of which 38.6 square miles are too steep and broken for farming. The more gentle slopes of the benches and the isolated upland tracts are under cultivation and are devoted largely to the production of small grains and forage crops. The yields on many of the tracts are good. The slopes of most of the benches have a good grass cover and they have a high livestock carrying capacity during the 7 to 8 months the area is free from snow.

LISMAS CLAY LOAMS

The surface few inches of the Lismas clay loams is a crusted fine-grained gray silty clay mulch. The lower soil depths are structureless, cloddy dark olive-drab clays, grading into disintegrated dark colored shales at one to 3 feet or more.

The Lismas clay loams occur on eroded shaly escarpments and on barren shaly ridges in the northern and eastern parts of the county. These heavy loams are classified as non-tillable grazing land on the land classification map and cover 64.8 square miles. Salt sage, greasewood, and black sage with light stands of western wheat grass in the less alkali impregnated coulee bottoms form the chief cover on the tracts. The forage on 65 to 75 acres or more would be required to carry a steer through a 10 months grazing season.

PIERRE CLAY LOAMS

The surface one to 3 inches of the Pierre clay loams is a crusted fine-grained gray, silty clay mulch, effervescing weakly with acid at or within a few inches of the surface. The poorly

defined humus-bearing layer, also effervescing weakly with acid, is a cloddy grayish-brown silty clay loam to clay loam, grading into non-calcareous dark olive-drab structureless clays, often having the platy structure of the parent material below 3 feet or more. A zone of alkali is found usually at 12 to 20 inches, and crystals of gypsum often are characteristic of the lower soil depths. The Pierre clay loams are associated with the Lismas clay loams.

The Pierre clay loams cover rolling hills and ridges in the northern and eastern parts of the county. The areas are drained by intermittent streams of a cut-bank type. These clay loams, classified as non-tillable grazing land on the land classification map, cover 158.6 square miles of which 47.4 square miles are sharply rolling. The tracts are not under cultivation and are utilized for the grazing of livestock. Black sage, associated with western wheatgrass and an occasional patch of grama grass, forms the chief cover. The livestock carrying capacity of the Pierre clay loams is very low, and the forage on 50 to 60 acres or more would be required to carry a steer through a 10 months grazing season.

Pierre Clay Loams — Timbered Phase

The more rolling and broken phases of the Pierre clay loams in the northeastern part of the county have an open stand of yellow pine on the broken ridges. The timber does not greatly influence the character of soil on the tracts, except immediately under the trees. The soils on the more eroded slopes grade into the Lismas clay loams.

The timbered phase of the Pierre clay loams, classified as non-tillable grazing land on the land classification map, covers 277.4 square miles of broken shaly ridges in the northeastern part of the county. This phase, covered with an open stand of scrubby yellow pine, supports a light stand of wheat bunch grass (*Agropyron spicatum*), which is one of the more important forage plants for winter grazing in the breaks of the Missouri River. Black sage associated with western wheatgrass also occurs on the more open tracts. The land has a very low livestock carrying capacity.

Pierre Clay Loams — Level Phase

Several undulating tracts having the relief of benches occur in the northeastern part of the county. The land is characterized by shallow depressions and by a few boulders and some glacial gravel on the surface. The soil development on the tracts does not differ greatly from that of the Pierre clay loams. The sub-soils are somewhat more highly impregnated with alkali, and layers and masses of yellowish-colored crystals of gypsum are

often encountered in the lower soil depths. Locally the heavy drift is of sufficient depth to modify the character of the soils, and the soils grade into the Phillips loams. The gravel phase of these heavy loams, classified as grazing land and non-tillable grazing land on the land classification map, cover 25.8 square miles. Black stage associated with western wheatgrass forms the chief cover. The land has a low livestock carrying capacity during the 10 months the area is open for grazing.

GERHARD CLAY LOAMS

The surface 2 to 3 inches of the Gerhard clay loams is a fine-grained gray silty clay mulch. The humus-bearing layers are grayish-brown silty clay and clay loams effervescing with acid at 3 to 8 inches below the surface. The lower depths show a slight concentration of carbonates in the upper part, but below 3 to 4 feet consist largely of compact olive-drab clays, locally having the platy structure of the parent shales.

The Gerhard clay loams cover rolling to broken tracts in the north central, northeastern, and southeastern parts of the county. These heavy loams are classified as grazing forage land and non-tillable grazing land on the land classification map and cover 98.7 square miles of which 68.1 square miles are suitable for cultivation. These loams were placed under cultivation between 1913 and 1915 but during the dry years of 1918 to 1920 the cropped acreage was greatly reduced. In 1930, approximately 10 per cent of the tillable phase was under cultivation, and the cropped acreage, devoted chiefly to spring wheat, was confined largely to tracts in the vicinity of Winifred. The surface acre foot of soil contains 2200 to 2700 pounds of nitrogen and 1200 to 1500 pounds of phosphorus. The yields of spring wheat on summer fallowed land average less than 10 bushels per acre, with occasional yields of 15 to 20 bushels or more in favorable seasons. The soils drift when pulverized by frost or by farm implements. Western wheat grass associated with black sage forms the chief cover. The forage on 30 to 35 acres would carry a steer through a 10 months grazing season.

Gerhard Clay Loams — Deep Phase

The deep phase of the Gerhard clay loams differs chiefly from the clay loams in having somewhat darker colored and more cloddy compact tenacious humus-bearing layers. The carbonates are well concentrated at 6 to 8 inches below the surface and the lower depths consist chiefly of olive-drab clays.

The deep phase of the Gerhard clay loams is confined chiefly to tracts in the northeastern part of the county along Crooked and Box Elder creeks. This phase, classified as grazing land and

as non-tillable grazing land on the land classification map, covers 40.1 square miles of which 10.4 square miles are sharply rolling. The land was placed under cultivation before 1917, but the soils were too refractory for farming and it has been abandoned. Black sage is abundant on these heavy loams, and a few more acres would be required to carry a steer through a 10 months grazing season here than on the clay loams.

Gerhard Clay Loams — Shallow Phase

The shallow phase of the Gerhard clay loams differs chiefly from the Pierre clay loams in having no free carbonates or lime in the surface mulch and in the upper one to 2 inches of the poorly defined humus-bearing layers. The lower depths are chiefly deep structureless olive-drab clays.

The shallow phase of the Gerhard clay loams covers tracts of level to undulating land in the northeastern part of the county. This phase, classified as non-tillable grazing land on the land classification map, covers 138.6 square miles. The land is not under cultivation except for small tracts locally devoted to forage. Black sage associated with western wheat grass and an occasional patch of grama grass forms the chief cover. The livestock carrying capacity of these heavy loams also is low, and the forage on 50 acres or more would be required to carry a steer through a 10 months grazing season.

WINIFRED CLAY LOAMS

The Winifred clay loams have the characteristic regional grayish-brown fine-grained silty clay mulches on the surface. The humus-bearing layers, often underlaid with very compact sub-surface layers, are fine-grained to small cloddy grayish-brown to dark grayish-brown silty clay and clay loams with a fair columnar structure. The well developed grayish olive-brown carbonate zone below 8 to 14 inches is a compact clay loam, streaked and blotched with lime. The lower soil depths are massive olive-brown clays and silty clays. The soils on the tracts north of Box Elder Creek in T. 19 N., R. 22 E. are chiefly dark colored cloddy, tenacious, refractory clays.

The Winifred clay loams cover undulating to sharply rolling tracts in the north central, northeastern, and east central parts of the county along such streams as the Judith River and Dog, Armells, Box Elder and other creeks. These heavy loams are classified as farming land, farming grazing land, and non-tillable grazing land on the land classification map and cover 211.3 square miles of which 83.0 square miles are too hilly and dissected with coulees for farming.

Utilization.—The Winifred clay loams were placed under cul-

tivation at the time of settlement of the dry land areas of the county but since 1919 the cropped acreage has been declining steadily. In 1930 approximately 30 per cent of the tillable land was under cultivation. The cropped acreage was distributed largely over the more friable soils in the vicinity of Winifred and locally on the tracts north of Box Elder Creek. Spring and winter wheat with a small acreage devoted to forage crops are grown on these heavy loams. The surface acre foot of soil contains 2700 to 3000 pounds of nitrogen and 1500 to 1800 pounds of phosphorus. The yields of spring wheat on summer fallowed land average between 8 and 12 bushels per acre with occasional yields of 20 to 25 bushels in favorable seasons. Clean summer fallowed land drifts when the surface soils are in the proper physical condition.

Vegetation.—Western wheat grass with some black sage creeping in on the tracts in the northeastern part of the county forms the chief cover. The density of the grass cover varies on the different tracts but on an average 30 to 35 acres would carry a steer through a 10 months grazing season.

Winifred Clay Loams — Gravelly Phase

The Winifred clay loams, on the tracts south of Box Elder Creek in the east central part of the county, locally have a shallow covering of gravel on the surface, which does not greatly modify the character of the soils.

The clay loams and gravelly silty clay loams, developed over shales and over wash from the gravel-capped benches in the Sage Creek Basin in the west central part of the county, were undifferentiated and are designated on the soil map as a gravelly phase of the Winifred clay loams. These soils effervescing with acid at 3 to 10 inches or more are quite variable in character.

The gravelly phase of the Winifred clay loams covers gently rolling tracts along Box Elder Creek in the east central part of the county and the gentle slopes and ridges in the Sage Creek Basin in the west central part. The slopes of the basin are dissected with coulees and the drainage courses often are seeped and impregnated with alkali. The gravelly phase, classified as farming grazing land and non-tillable grazing land on the land classification map, covers 25.2 square miles of which 18.2 square miles are too broken for cultivation. The tillable land on the tracts was placed under cultivation, but with comparatively low average yields of spring wheat the cropped acreage has been steadily declining. A fair acreage was devoted to the production of sweet clover in the Sage Creek Basin in 1930. Western wheat grass predominates on the tracts and the forage on 25 to 30 acres of native grass land would carry a steer through a 10 months grazing season.

POWER CLAY LOAMS

The Power clay loams have grayish-brown, laminated fine-grained silty clay surface mulches, the lower part of which often has a platy structure. The very dark grayish-brown humus-bearing layers range from granular silty clay loams to small cloddy tenacious clay 5 to 7 inches thick. The subsurface layers are compact, tenacious clay. The grayish olive-brown heavy carbonate zone below 12 to 20 inches or more is streaked and blotched with lime. The lower depths are massive olive-brown clays.

The Power clay loams occur on undulating to gently rolling tracts in the northern part of the county along such streams as the Judith River, Dry Wolf Creek, and Dog Creek. These heavy loams, classified as farming land, as farming grazing land, and non-tillable grazing land on the land classification map, cover 60.6 square miles of which 8.1 square miles are broken with deep coulees.

Utilization.—The Power clay loams are productive but rather refractory soils for farming above the ditch. In 1930, approximately 50 per cent of the tillable land was under cultivation and devoted chiefly to spring and winter wheat, grown on summer fallowed land. The cropped acreage was distributed largely over the tracts in the northwestern part of the county. The surface acre foot of soil contains 3000 to 4000 pounds of nitrogen and 1500 to 2000 pounds of phosphorus. Locally the soils on the crests of divides between Coffee and Dry Wolf creeks and between Dry Wolf Creek and the Judith River contain as much as 6000 pounds of nitrogen in the surface acre foot. The yields of spring wheat on summer fallowed land average between 10 and 12 bushels per acre on the more tenacious clay and from 12 to 15 bushels on the more friable silty clay loams. Average yields of 15 to 18 bushels per acre are locally obtained on the darker colored soils on the crests of divides. Summer fallowed land occasionally drifts.

Vegetation.—Western wheat grass predominates on these heavy loams and the forage on 20 to 25 acres would carry a steer through a 10 months grazing season.

Power Clay Loams — Dark Phase

The dark phase of the Power clay loams includes a group of rather shallow soils developed over shales in the central and south central parts of the county. This phase is characterized by very dark brown granular silty clay surface mulches, containing a fair amount of root fiber. The humus-bearing layers are very dark brown granular silty clay loams. The subsoils effervescing with acid at various depths are dark olive-brown structureless

clays streaked and blotched with lime. The tracts often are underlaid at comparatively shallow depths with disintegrated shale. The deeper soils are found in basins between the Moccasin and Judith mountains and on the more gentle slopes of the divide south of the South Fork of McDonald Creek.

The dark phase of the Power clay loams occurs in undulating basins between the Moccasin and Judith mountains and on the rolling to broken slopes of the divide south of the South Fork of McDonald Creek. Other tracts are found on the northern slopes of the Judith Mountains. This phase, classified as farming land, farming grazing land, and non-tillable grazing land on the land classification map, covers 17.4 square miles of which 6.5 square miles are sharply rolling.

Utilization.—Stock raising and grain growing are usually combined on the dark phase of the Power clay loams. The cropped acreage in 1930, amounted to 60 per cent of the tillable phase. It was confined chiefly to the deeper soils in the basins between the mountains and on the more gentle slopes of the divide south of Piper. The deeper soils under cultivation are devoted largely to the production of spring and winter wheat. The more shallow soils are not under cultivation and are devoted to the production of wild hay or used for the grazing of livestock. The surface acre foot of soil contains 5000 to 8000 pounds of nitrogen and 1500 to 2000 pounds of phosphorus. Land summer fallowed occasionally to control weeds produces between 15 to 18 bushels of spring wheat per acre in normal seasons and higher yields in more favorable years.

Vegetation.—The land has a dense cover of the tall grasses and a high livestock carrying capacity during the 7 to 8 months the areas are free from snow.

MARIAS CLAY LOAMS

The Marias clay loams have deep, loose grayish-brown fine-grained silty clay surface mulches which effervesce freely with acid. The humus-bearing layers, also effervescing freely with acid, are grayish-brown to dark grayish-brown cloddy silty clay and clay loams 5 to 6 inches thick. The subsoils are deep compact grayish olive-brown clays, streaked and blotched with lime to a depth of 30 inches or more. Occasionally, the more poorly drained phases in basins and on gentle slopes have an alkali zone in the lower depths. These heavy loams covering isolated gently rolling tracts in different parts of the county are classified chiefly as grazing land on the land classification map and cover 20.2 square miles.

Utilization.—The Marias clay loams are rather refractory soils for dry land farming, but when summer fallowed a season to

accumulate moisture in the subsoils, they produce fair yields of spring and winter wheat in normal years. In 1930, approximately 40 per cent of the area was under cultivation. The surface acre foot of soil contains 2000 to 4000 pounds of nitrogen and 1500 to 1800 pounds of phosphorus. The yields of spring wheat on summer fallowed land average between 8 and 12 bushels per acre with occasional yields of 20 to 25 bushels. Soil drifting has been difficult to control on most of the tracts during the early spring.

Vegetation.—Western wheat grass associated with black sage forms the chief cover and the forage on 30 to 35 acres would carry a steer through a 10 months grazing season.

PHILLIPS CLAY LOAMS

The Phillips clay loams include an undifferentiated group of soils characterized by bare or scab spots depressed several inches below the surface. These soils have developed in areas underlaid with shale in Fergus County. The grassed-over portion of these clay loams has in general the profile of the deeper phases of the Gerhard clay loams. The soil mulch is somewhat more pronounced and the humus-bearing layers are more compact. The bare spots have a firm crust on the surface, below which is a vascular or honey-comb structured layer of an inch or more. This honey-comb structured layer overlies an impervious nutty structured brown silty clay to clay layer which grades into calcareous olive-brown clays, occasionally flecked with lime and alkali. The lower depths are similar to those found under the grassed-over portion of the tracts. The Phillips clay loams include some alkali impregnated soils which have an imperfectly developed hardpan layer.

The Phillips clay loams occupy undulating slopes and basins in the northern and northeastern parts of the county. These loams are classified as non-tillable grazing land on the land classification map and cover 45.0 square miles. The land is not under cultivation except for small tracts receiving the runoff from the higher levels. Black sage associated with western wheat grass forms the chief cover. The tracts have a comparatively low live-stock carrying capacity during the 10 months the area is open for grazing.

BOX ELDER LOAMS AND SILTY CLAY LOAMS

The Box Elder loams and silty clay loams, characterized by numerous bare or scab spots on the surface, occur on secondary benches or high terraces in the basin along Armells Creek in the north central part of the county. The silty clay loams occupying the upper part of the basin cover 3.3 square miles. The grassed portions of these heavy loams are dark grayish-brown cloddy silty clay loams and clay loams underlaid with compact sub-sur-

face layers. The heavy carbonate zone below 10 to 14 inches grades into stratified gravels with depth. The area shown separately on the soil map is not under cultivation except for a small irrigated acreage devoted chiefly to wild hay. Scabby loams with stratified gravels within 6 to 15 inches of the surface cover 1.3 square miles in the east central portion of the basin. The tract is not under cultivation except for a few acres of the less scabby land along Armells Creek. Very scabby gravelly loams covering 15.3 square miles occupy the northern and western parts of the basin. The glazed gravelly surface of these loams is quite barren except for a light stand of black sage associated with western wheat grass. Greasewood occurs locally on the more poorly drained alkali impregnated phases. The profile of the bare spots with gravel imbedded in the glazed surface is similar to that found in the Phillips clay loams. The Box Elder loams and silty clay loams have a low livestock carrying capacity.

WADE LOAMS

The Wade loams include a group of undifferentiated dark colored soils located in the larger stream valleys below the mountains and foothills. The soils in the valley of Big Warm Springs, such as found in the vicinity of Brooks, are very dark grayish-brown friable gravelly loams with carbonate zones 6 to 10 inches below the surface. The lower depths are stratified gravelly silt loams. The soils of the valley are all under cultivation and are among the most productive soils in the county. Dark colored gravelly loams and loams, also underlaid with stratified gravels and silts, cover the valley of Big Spring Creek. The lower levels along the creek west of Lewistown are poorly drained and grade into the Chouteau loams. The better drained phases are under cultivation and the poorly drained phases are used chiefly for wild hay land. The soils in the upper part of the Dog Creek Valley have about the same soil development as those in the valley of Big Warm Spring Creek. The soils of this valley are silt and silty clay loams, locally grading into gravelly loams underlaid at fair depths with stratified gravels. The soils are locally refractory and poorly drained but otherwise are fair farm lands. The soils in the valley of Wolf Creek are gravelly loams effervescing with acid at 10 to 15 inches below the surface. The subsoils are porous stratified gravel and sands. The land is locally under cultivation but it is used largely for pasture and hay lands. The poorly drained gravelly stony loams in the valley of Box Elder Creek west of Roy are utilized chiefly for wild hay land. The soils on the higher levels show some maturity, but in a more detailed survey a large portion of the valley would be grouped in the Chouteau loams.

The silt and silty clay loams, underlaid with stratified gravelly silts and clays in the valley of McDonald Creek near Grass Range, are rather immature and are not under cultivation except where flood waters are diverted onto the land. The mature deep dark-colored gravelly silty clays in the upper part of the valley of Bear Creek are utilized chiefly for wild hay lands. Poorly drained gravelly loams underlaid with stratified gravelly subsoils cover the upper part of the valley of Flatwillow Creek and deep silty clay loams locally stratified, the lower part. The soils of this valley also are rather immature and unless the land is under irrigation it is used chiefly for pasture and wild hay lands. The silty clay loams are under irrigation and are devoted largely to the production of alfalfa. Other tracts, covering small acreages of the Wade loams, are found in the stream valleys extending out from the mountains.

The Wade loams, dissected with meandering stream courses, cover the valleys of larger streams in the vicinity of the mountains. These loams, classified largely as farming land and grazing land on the land classification map, cover 84.4 square miles.

Utilization.—The better drained phases in most of the stream valleys are under cultivation and are devoted largely to the production of small grains and forage crops. The perennial flow and flood waters of streams are used for irrigation in many of the valleys. The Wade loams have a good grass and shrub cover and a high livestock carrying capacity.

Wade Clay Loams

The Wade clay loams are very dark grayish-brown granular fine cloddy silty clay and clay loams, underlaid with compact subsurface layers. The carbonate zone below 9 to 12 inches is a compact silty clay loam streaked and blotched with lime. The lower depths are chiefly stratified olive-brown, silty clays and clays, locally stratified and underlaid within limestone gravel.

The Wade clay loams occur on low terraces in the valley of Ross Fork Creek. These heavy loams, classified as farming land on the land classification map, cover 3.2 square miles. The land is under cultivation and is devoted to the production of small grains and forage crops. The yields of spring wheat on summer fallowed land average high. The native sod lands have good grass cover and a high livestock carrying capacity.

CHEYENNE GRAVELLY SANDY LOAMS

The Cheyenne gravelly loams have a shallow dark-colored sandy mulch on the surface. The humus-bearing layers are dark to very dark grayish-brown, columnar structured gravelly sandy loams. The gray semi-consolidated sandy gravelly carbonate zone

lies below 6 to 12 inches and grades into stratified loose sands and gravels at 2 to 3 feet or more.

The Cheyenne gravelly sandy loams occur on secondary benches dissected with coulees along the Judith River and Ross Fork Creek in the west central part of the county. These gravelly loams, classified as farm land on the land classification map, cover 29.7 square miles, nearly all of which is under cultivation and continuously cropped to spring wheat. The surface acre foot of soil contains 4000 to 5000 pounds of nitrogen and 1800 to 2000 pounds of phosphorus. These gravelly sandy loams produced fair yields of spring wheat for a number of years after the land was placed under cultivation, but with the progressive loss of the surface soils by soil drifting the yields have declined, and at the present time the average yield of spring wheat is between 8 and 12 bushels per acre. The farm lands in some sections of the benches have been abandoned because of soil drifting. The tall grasses predominate on these loams, and the forage on 20 acres of native sod land would carry a steer through a 9 to 10 months grazing season.

Cheyenne Sandy Loams — Dark Phase

The surface soils of the dark phase of the Cheyenne sandy loams are very dark brown friable sandy loams and fine sandy loams, with a well developed columnar structure in the lower part. The slightly heavier textured compact gray sandy carbonate zone lies below 10 to 17 inches and grades into stratified sands, containing some limestone gravelly layers in the lower depths.

The dark phase of the Cheyenne sandy loams occupies secondary benches along Ross Fork Creek in the southwestern part of the county. This phase, classified as farming land on the land classification map, covers 8.4 square miles nearly all of which is under cultivation. The surface acre foot of soil contains 5000 to 6000 pounds of nitrogen and 1500 to 2000 pounds of phosphorus. The yields of spring wheat on summer fallowed land average between 15 and 20 bushels per acre. Some soil drifting has occurred on these sandy loams in recent years. The land had a good grass cover before it was placed under cultivation and a high livestock carrying capacity during the 7 to 8 months the benches are free from snow.

Cheyenne Gravelly Loams

The Cheyenne gravelly loams have very dark brown, friable, columnar structured surface soils effervescing with acid at 7 to 10 inches below the surface. The lower depths are largely stratified gravel and silts. The soils on the lower benches along Big Warm Spring Creek are quite gravelly, and along Wolf Creek a few of the benches carry some rock on and below the surface.

The Cheyene gravelly loams occur on low benches or high terraces along such streams as Big Warm Spring and Wolf creeks. These gravelly loams, classified as farming land on the land classification map, cover 8.4 square miles, nearly all of which is under cultivation and is devoted to the production of small grains. The yields of spring wheat on the less gravelly phases average between 15 and 20 bushels per acre. The land had a good grass cover and a high livestock carrying capacity.

BEAVERTON LOAMS

The surface soils of the Beaverton loams below a shallow sandy surface mulch are dark grayish-brown columnar structured loams and gravelly loams, effervescing with acid at 6 to 8 inches below the surface. The lower soil depths are largely stratified sands and gravels.

The Beaverton loams occur on several low benches along Dog Creek in the north central part of the county. These loams, classified as farming land on the land classification map, cover 1.6 square miles, most of which is under cultivation. The soils are rather droughty for dry-land farming and the yields of spring wheat on summer fallowed land average less than 12 bushels per acre. The land had a good cover of grama grass, and the forage on 20 to 25 acres would have carried a steer through a 10 months grazing season.

ORMAN CLAY LOAMS

The surface soils of the Orman clay loams are grayish-brown to dark grayish-brown cloddy silty clay and clay loams, effervescing with acid at 4 to 6 inches below the surface. The lower depths are olive-brown stratified silty clays and clays, flecked with lime and alkali. The soils grouped in this series in the valley of Coffee and Dog creeks have dark-colored surface soils and alkali and lime flecked subsoils.

The Orman clay loams occur in an ancient stream course in the north central part of the county and also cover several small tracts in the valleys of Coffee and Dog creeks. These clay loams, classified as non-tillable grazing land on the land classification map, cover 10.0 square miles which is utilized chiefly for the grazing of livestock. Black sage predominates in the ancient stream course in the north central part of the county and western wheat grass, on the tracts in Coffee and Dog creek valleys. The land has a low livestock carrying capacity.

CHOUTEAU LOAMS

The Choteau loams include a group of undifferentiated dark colored soils covering the stream bottoms in the mountains and foothills and many of the poorly drained depressions or basins

between the gravel-capped benches. Local seeped areas on the slopes of the benches also are included in this soil series. These soils range in texture from loams to gravelly loams in the basins to stony loams in the mountains and foothills. The soils, occasionally effervescing with acid, are stratified and are without distinct soil horizons, except those produced by poor drainage.

The Chouteau loams, classified chiefly as non-tillable land on the land classification map, cover 121.8 square miles. Locally, the valley lands are subirrigated and irrigated and are devoted to the production of forage crops such as timothy. The poorly drained subirrigated lands often are valuable wild hay lands in the mountains and foothills. The valley of Wolf Creek in the west central part of the county is poorly drained and swampy and is utilized chiefly for grazing and for wild hay. Swampy tracts also are found along Ross Fork Creek. The first stream bottoms are covered largely with wire grass, sedges and willows and have a high livestock carrying capacity during the time the tracts are free from snow.

LAUREL LOAMS

The Laurel loams include a group of undifferentiated gray calcareous soils covering the valleys of streams in the northern and eastern parts of the county. The soils are stratified and range in texture from loose sands and gravels to refractory silty clays and clays, without distinct soil horizons. Silty clay and clay loams predominate on the terraces and slopes of the Missouri and Judith river valleys below the shaly breaks. The valleys of many of the streams in the north-eastern and east central parts of the county are broad alkali flats. The location of these alkali impregnated stream bottoms is designated on the soil map as an alkali phase of the Laurel loams.

The Laurel loams, classified largely as non-tillable land on the land classification map, cover 188.3 square miles of which 85.1 square miles are alkali flats. The stream valleys are not under cultivation, except for local tracts of sub-irrigated and irrigated lands lying on low terraces and on wash slopes above the high water level. Most of the cultivated tracts are devoted to alfalfa for the production of hay and seed. The subirrigated and less alkali impregnated bottoms along the larger streams, such as the Missouri and Judith rivers, locally have a dense growth of cottonwoods, willows, and such shrubs as rose bushes. The better drained phases often have a fair cover of grama grass and western wheat grass. Black sage predominates on the slopes and terraces covered with wash from the shaly breaks. Sedges form the chief cover in the sloughs and alkali grass and greasewood on the alkali flats. The livestock carrying capacity of the Laurel loams in the different stream valleys varies greatly, but in general it is low.

AGRICULTURAL DEVELOPMENT

The development of agriculture in Fergus County dates from the early 80's when many prospectors turned their attention to stock raising as a more dependable and less strenuous means of gaining a livelihood than mining. The herds of these early stockmen increased rapidly, and in competition for the public range land, cooperative associations and stock corporations were formed to obtain control and legal title to water holes and grazing lands. After the railway entered the county and the tillable public range land was homesteaded and placed under cultivation, many of these stock organizations dissolved, and their ranch holdings in the more favorable agricultural sections were subdivided and sold in tracts of 160 to 320 acres or more. Fergus County was fortunate in attracting, chiefly from the central states, settlers who in most cases had sufficient capital to equip their farms and to develop the area. Crop yields were high and farm prices were good for a number of years after the land was placed under cultivation. These yields and prices were reflected in the rapid rise in value of farm lands, the construction of branch railway lines, and the development of urban centers. Since 1927, the yields and prices of farm products have averaged much lower and farm land values have depreciated greatly.

The general trend of agriculture in Fergus County is shown by the United States Census Reports for 1930 and 1935. The data before 1930 are not comparable as Petroleum County was created from the eastern part of the county in 1925. In 1930, 67.3 per cent of all the farm lands in the county had a mortgage indebtedness of \$9.42 on land valued at \$20.22 per acre. The 1935 data, which are not available, will probably show a decline in mortgage indebtedness and also in farm land values. The farm tenancy has increased from 32.6 per cent in 1930 to 36.3 per cent in 1935. The percentage of the total area of the county in farms for the 5-year period increased from 55.2 to 67.9 per cent. The number of farms decreased during the same period from 2073 to 1999, while the acreage per farm increased from 807.0 to 939.3 acres. Land values have depreciated during the past few years, but in the better farming sections the land is priced at \$15.00 to \$30.00 per acre with irrigated lands held at \$50.00 per acre or more. Nontillable grazing land ranges in price from less than \$1.00 per acre in the breaks of the Missouri and Judith rivers to over \$5.00 per acre in the foothills, depending upon the livestock carrying capacity, water holes, and location. The gross agricultural income for the county is derived largely from livestock and from farm products grown on the dry and irrigated farms.

STOCK RAISING

The foothills of the mountains, the breaks of streams, and the

heavy soil areas in the northeastern part of the county are primarily grazing sections. The more valuable grazing lands, such as found in the foothills, are largely fenced and are under controlled grazing, while the less valuable grazing lands in the northern and eastern parts of the county often are open range land with uncontrolled grazing. In the vicinity of the mountains the larger stock companies usually run their stock in the mountains and on leased or privately owned land in the foothills during the grazing season, and winter their herds on home ranches located in the larger stream valleys. The small stockmen, also leasing tracts in the foothills and making use of the National Forest Reserve during the summer months, often supplement their winter grazing lands with straw and small grain hays grown on the dry-land farms. In the northern part of the county, a few stockmen in the Missouri River Valley do some winter feeding, but many of them winter their stock in the breaks and during severe winter weather supplement the winter grazing land with commercial feeds such as cotton seed cake. The county is well supplied with stock water, except the northeastern part where the streams often shrink into stagnant water holes during the late summer and fall.

Cattle.—Grade Shorthorns and Herefords are the more important beef breeds found on the farms and ranches. The total number of cattle in the county in 1930 was 53,787 and 54,042 in 1935, of which 8354 were used for milking purposes in 1930. Most of the cows used for milking purposes are crosses of the beef and dairy breeds.

Sheep.—The range conditions in Fergus County are somewhat more favorable for running cattle than sheep. Sheep were brought into the county at an early date but they have not competed with cattle until recent years. The number of sheep on the farms and ranches in 1930 was 116,222 and in 1935 was 126,564. Rambouillet is the more important breed on the range.

Horses and Swine.—The number of horses on the farms has declined steadily with the increasing use of small tractors, as in other counties in the state. The number of horses reported was 18,234 in 1930 and 15,056 in 1935. The swine industry is unimportant as only 1280 head were found on the farms and ranches in 1935. The Duroc Jersey is the most popular breed.

CROP PRODUCTION PRACTICES AND PROBLEMS

One of the more important problems in Fergus County is the consolidation of farms of 160 acres or less on the benchlands into larger and more economical farm units. The set-ups of many of the large stock ranches are good, but in many cases greater utilization could be made of the irrigated and other agricultural lands in connection with the stock ranches. The grazing lands can support more

stock during the grazing season than can be wintered in the area on the feed produced on the dry and irrigated farms.

Dry Land Farming

Acreage.—The assessed non-irrigated tillable land in Fergus County in 1934 was 850,286 acres. The 1935 Census reports a total of 545,990 acres of non-irrigated and irrigated crop lands, of which 344,546 acres produced harvested crops, 185,991 acres were idle or fallow land, and 55,194 acres were listed as crop failures. During the past 5 years the average acreage of farm land has been 576,865 acres.

Crops.—An extensive type of grain farming is practiced on the benches and plateaus in Fergus County. The larger grain farms often have an annual cropped acreage of 200 to 400 acres or more, which is largely devoted to the production of spring and winter wheat. Tractor operated types of farm machinery are employed on the large grain farms. In the vicinity of the foothills and about the borders of the benches, stock raising often is combined with grain growing and a fair acreage is devoted to forage crops. Exclusive stock raising is carried on largely in the more broken sections, such as in the foothills and in the heavy soil areas covering the northern and eastern parts of the county.

The crops grown in Fergus County are chiefly the early and medium early maturing varieties of small grains and forage crops. The more important small grains are wheat, oats, barley, rye, and flax. Approximately 65 per cent of the total harvested acreage in the county during the past 5 years has been devoted to the production of wheat. The average acreage devoted to wheat since 1930 has been 225,226 acres, 35 per cent of which was devoted to winter wheat and the other 65 per cent to spring wheat. Winter wheat was almost exclusively grown in the Judith Basin for a number of years after the benchlands were brought under cultivation. Since 1915, winter wheat has winter killed too frequently to be depended upon and spring wheat is more generally grown. The climatic conditions in the Basin and on the high benchlands are somewhat more favorable for the growing of winter wheat than spring wheat as winter wheat is usually well along to maturity before the dry weather sets in during the last of July. The yields of spring wheat and other spring seeded small grains often are reduced greatly by drought late in July and August. The minor crops, such as oats, barley, rye and flax, are grown on a limited acreage. The climate is too cool to mature the semident varieties of corn, hence only a small acreage is grown.

The average acreage devoted to wild and tame hay the past 5 years has been 85,959 acres of which approximately 12 per cent was wild hay. Alfalfa is grown on an average acreage of 33,014; small grains, such as oats, on an 18,900 acreage; and other mis-

cellaneous forage crops, such as sweet clover and the tame grasses, on the remaining acreage. Sweet clover is grown occasionally for pasture and for hay in short rotations on the dry-land farms. The yields of alfalfa on the benchlands are comparatively low, ranging from three-fourths to one and one-quarter ton per acre. Somewhat higher alfalfa yields are obtained in the foothill areas. The yields of root crops such as potatoes also average low. The quantity of potatoes produced in the area is not sufficient for home consumption.

Dry Farming Problems.—Continuous cropping to spring and winter wheat with an occasional summer fallow to control weeds has resulted in severe soil drifting on the lower benchlands and on other lands, after the root fibre has been destroyed. The drifting of soils has been progressive and is becoming increasingly more difficult to control. During the past few years, the soils on some of the higher benches also have drifted when not protected with a vegetative cover. Cultural methods such as ridging the land and leaving the stubble on the surface have been ineffective in controlling soil drifting during dry windy seasons. Strip farming and seeding a greater acreage to grasses and legumes are probably the most practical means of holding the soils in place.

The yields of small grains under the same cultural method often vary greatly in different localities. These variations in yields are attributed usually to poor farming and low rainfall. Soil drifting, reducing the water holding capacity of the surface soils and influencing the effectiveness of the seasonal rainfall, is probably an important factor in the variation of crop yields on the older cropped lands. Analyses of the potential fertility of the land in the county indicate that the original fertility of the soils also may be a factor.

Irrigation Development

The irrigated lands, located chiefly in the larger stream valleys, are largely privately owned enterprises used in connection with the stock ranches. The larger irrigated tracts are found in the valleys of such streams as Flatwillow, Cottonwood, McDonald, Box Elder, Warm Springs, Big Warm Springs, Armells, Ford and other creeks. Pumping and a few gravity projects also are distributed through the valleys of the Judith and Missouri rivers. In the east central part of the county the spring runoff is often diverted onto hay lands in the stream valleys. In the northeastern and in other parts of the county a fair acreage could be irrigated by impounding the flood waters and by the construction of diversion weirs.

The Judith Basin Irrigation District, located 25 miles north of Lewistown, diverts water by gravity from Warm Springs Creek to cover a gross acreage of 4300 acres of which probably 3600 acres are irrigable. It is claimed an additional 4000 acres could be

placed under the ditch at a low cost. Approximately 1500 acres, devoted chiefly to alfalfa, have been irrigated since the district was created in 1919. The project is covered largely with a rolling phase of the Blaine stony loams and the Lloyd gravelly loams, occurring on gently sloping gravel-capped benches. The proposed irrigated lands include the lower part of the Deerfields Bench covered with the Lloyd gravelly loams, and the bench east of the Judith River, covered with the Danvers silty clay loams. The Danvers silty clay loams occupy a level to gently sloping bench and some difficulty would be experienced in draining a portion of it below the foothills; otherwise, the tract has fair drainage and the soils have fair fertility.

Irrigation Farming.—The rainfall in the foothill sections of Fergus County is sufficient on the northern and western slopes of the mountains to produce fair crops in normal seasons. During the seasons of favorable rainfall, the irrigation systems are not kept in repair and in dry seasons the canals and structures are not in shape for the demands placed upon them. The stony gravelly bottoms of many of the stream valleys often are in need of drainage, but in many cases the cost of reclamation would far exceed the value of land after drainage. These poorly drained bottoms will continue to be used for wild hay until the land in the area has a much greater value.

Crops and Acreage.—The acreage of irrigated land assessed in Fergus County in 1934 was 7,494 acres. The small grains grown under irrigation are chiefly the medium early maturing varieties.

TABLE 4.—ACREAGE AND YIELDS OF THE MORE IMPORTANT CROPS GROWN IN FERGUS COUNTY

	1930*		1935*		Average	
	Acre		Acre		Acre	
	yields		yield		yield	
	Acreage	Bu. or tons	Acreage	Bu. or tons	Acreage	Bu. or tons
Crop land harvested	384,287	—	304,805	—	344,546	—
Crop land—failure	25,738	—	55,194	—	40,466	—
Crop land—idle or fallow	198,716	—	185,991	—	192,353	—
Crop land—total	608,741	—	545,990	—	576,865	—
Barley	15,754	13 2	6,038	74.5	10,896	13.8
Corn—total	1,417	10 3	5,539	13.1	3,478	11.7
Flax	1,640	2.8	217	2.1	928	2.4
Hay—wild and tame	83,898	9	87,921	58	85,959	0.7
" —alfalfa	32,307	1.3	33,707	0.7	33,014	1.0
" —small grains grown for hay	12,271	0.6	25,530	0.5	18,900	0.5
Oats	13,102	14.9	12,653	15.5	12,877	15.2
Potatoes	663	66.4	949	52.9	806	59.6
Rye	487	8.6	1,096	5.2	791	6.9
Wheat—winter	49,245	18.2	110,569	17.1	79,907	17.6
Wheat—spring	211,711	8.7	78,928	8.0	145,319	8.3

*United States Census Report

Most of the better drained land is devoted to alfalfa at the lower elevations and to tame grasses at the higher. The poorly drained irrigated tracts are used largely for pasture and wild hay land. The production of winter feed is important in Fergus County.

Table 4 gives the acreage and yields of the more important crops grown in Fergus County since 1930. These data represent the entire county, no distinction being possible between crops grown under irrigation and on the non-irrigated lands.

FUEL AND WATER RESOURCES

The agricultural development of some sections of Montana is influenced by the water and fuel resources for domestic use. Most of Fergus County is supplied with excellent water for domestic use. Water is sometimes difficult to obtain at reasonable depths on the isolated gravel-capped benches, such as in the extreme west central and northwestern parts of the county. The water obtained from the Bear Paw and Claggett shales underlying the northeastern part of the county is often brackish and unfit for domestic and stock use. Domestic water in this part of the county is hauled usually from perennial springs and streams or impounded in reservoirs and cisterns.

The Kootenai formation, occurring in the foothills of the Big Snowy Mountains and on the McDonald Creek Divide, carries several fairly wide veins of coal, which are of a good quality for domestic fuel. Coal and wood obtained in the mountains and in the stream breaks are the chief sources of fuel in the county. Gas has been discovered in the Eagle and Judith river sandstones, but the quality has not been sufficient for commercial use.

ACKNOWLEDGMENT

Mr. Oscar Bartholomew, temporary assistant in the United States Bureau of Chemistry and Soils, assisted in the field work. The maps appearing in the publication were prepared by Mr. Ralph O. Lund and others. The writer appreciates the assistance of the Chemistry Department of the Montana Agricultural Experiment Station in making the chemical analyses and furnishing the data on which discussions of the more important plant foods in this bulletin are based. The author also wishes to express his appreciation of the cordial treatment accorded him by bankers, business men and county officials of Fergus County and others who assisted in the preparation of the maps and manuscript.

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BLAINE

COUNTY

COUNTY

PHILLIPS

COUNTY

CHOUTEAU

JUDITH

BASIN

COUNTY

PETROLEUM

SOIL RECONNOISSANCE
MONTANA

1930

FERGUS COUNTY

AREA UNDER CULTIVATION

LEGEND

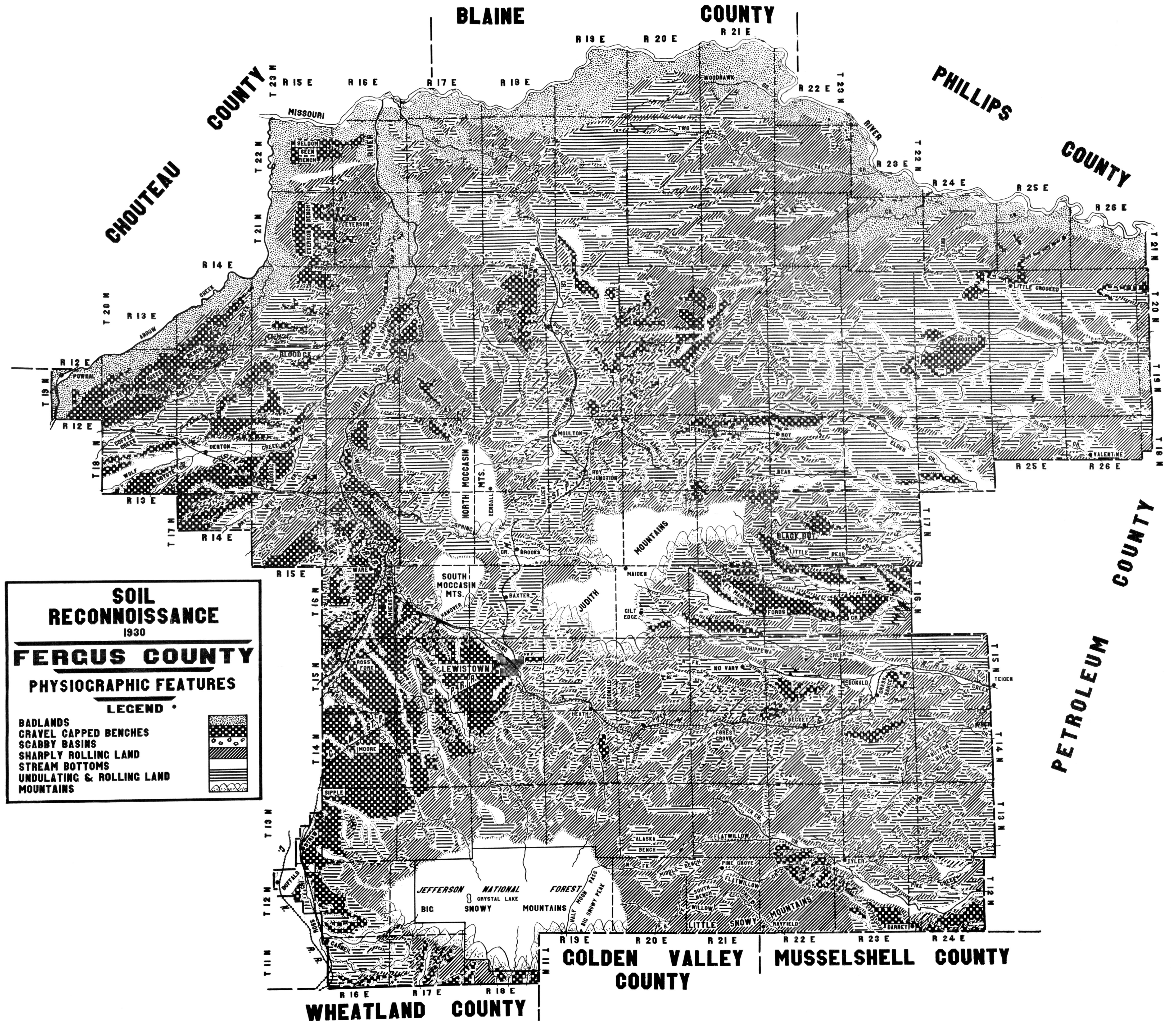
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10	"		60	"
15	"		70	"
20	"		80	"
30	"		90	"
40	"		100	"

WHEATLAND COUNTY

GOLDEN VALLEY
COUNTY

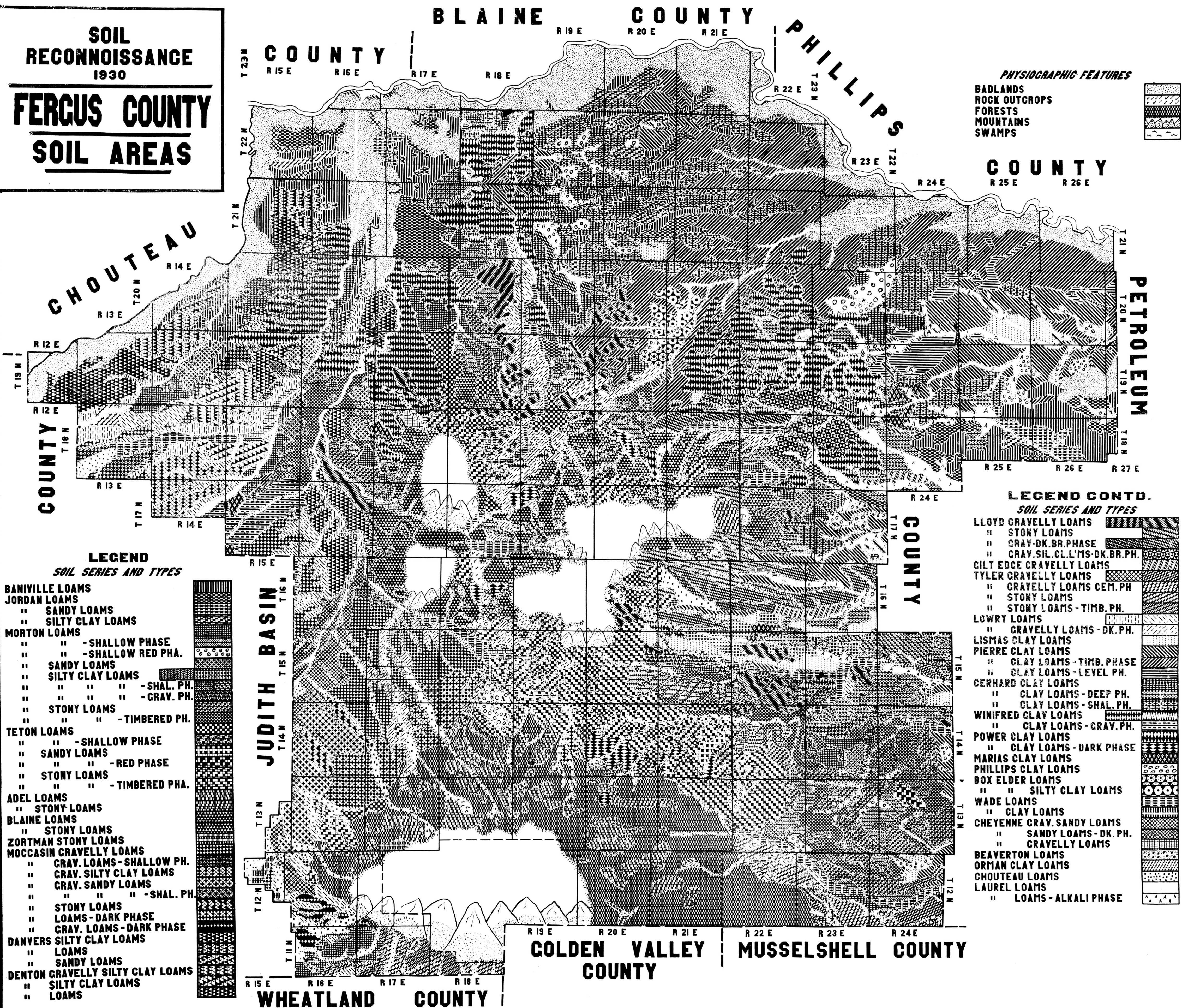
MUSSELSHELL

COUNTY



SOIL
RECONNOISSANCE
1930

FERGUS COUNTY
SOIL AREAS



PHYSIOGRAPHIC FEATURES

BADLANDS
ROCK OUTCROPS
FORESTS
MOUNTAINS
SWAMPS



LEGEND

SOIL SERIES AND TYPES

BANVILLE LOAMS
JORDAN LOAMS
" SANDY LOAMS
" SILTY CLAY LOAMS
MORTON LOAMS
" - SHALLOW PHASE
" - SHALLOW RED PHA.
" SANDY LOAMS
" SILTY CLAY LOAMS
" " " - SHAL. PH.
" " " - CRAV. PH.
" STONY LOAMS
" " - TIMBERED PH.
TETON LOAMS
" - SHALLOW PHASE
" SANDY LOAMS
" " - RED PHASE
" STONY LOAMS
" " - TIMBERED PHA.
ADEL LOAMS
" STONY LOAMS
BLAINE LOAMS
" STONY LOAMS
ZORTMAN STONY LOAMS
MOCCASIN CRAVELLY LOAMS
" CRAV. LOAMS - SHALLOW PH.
" CRAV. SILTY CLAY LOAMS
" CRAV. SANDY LOAMS
" " " - SHAL. PH.
" STONY LOAMS
" LOAMS - DARK PHASE
" CRAV. LOAMS - DARK PHASE
DANVERS SILTY CLAY LOAMS
" LOAMS
" SANDY LOAMS
DENTON CRAVELLY SILTY CLAY LOAMS
" SILTY CLAY LOAMS
" LOAMS

LEGEND CONTD.

SOIL SERIES AND TYPES

LLOYD GRAVELLY LOAMS
" STONY LOAMS
" CRAV. DK. BR. PHASE
" CRAV. SIL. CL. L' MS - DK. BR. PH.
CILT EDGE CRAVELLY LOAMS
TYLER GRAVELLY LOAMS
" GRAVELLY LOAMS CEM. PH.
" STONY LOAMS
" STONY LOAMS - TIMB. PH.
LOWRY LOAMS
" GRAVELLY LOAMS - DK. PH.
LISMAS CLAY LOAMS
PIERRE CLAY LOAMS
" CLAY LOAMS - TIMB. PHASE
" CLAY LOAMS - LEVEL PH.
CERHARD CLAY LOAMS
" CLAY LOAMS - DEEP PH.
" CLAY LOAMS - SHAL. PH.
WINIFRED CLAY LOAMS
" CLAY LOAMS - CRAV. PH.
POWER CLAY LOAMS
" CLAY LOAMS - DARK PHASE
MARIAS CLAY LOAMS
PHILLIPS CLAY LOAMS
BOX ELDER LOAMS
" " SILTY CLAY LOAMS
WADE LOAMS
" CLAY LOAMS
CHEYENNE CRAV. SANDY LOAMS
" SANDY LOAMS - DK. PH.
" CRAVELLY LOAMS
BEAVERTON LOAMS
ORMAN CLAY LOAMS
CHOUTEAU LOAMS
LAUREL LOAMS
" LOAMS - ALKALI PHASE

